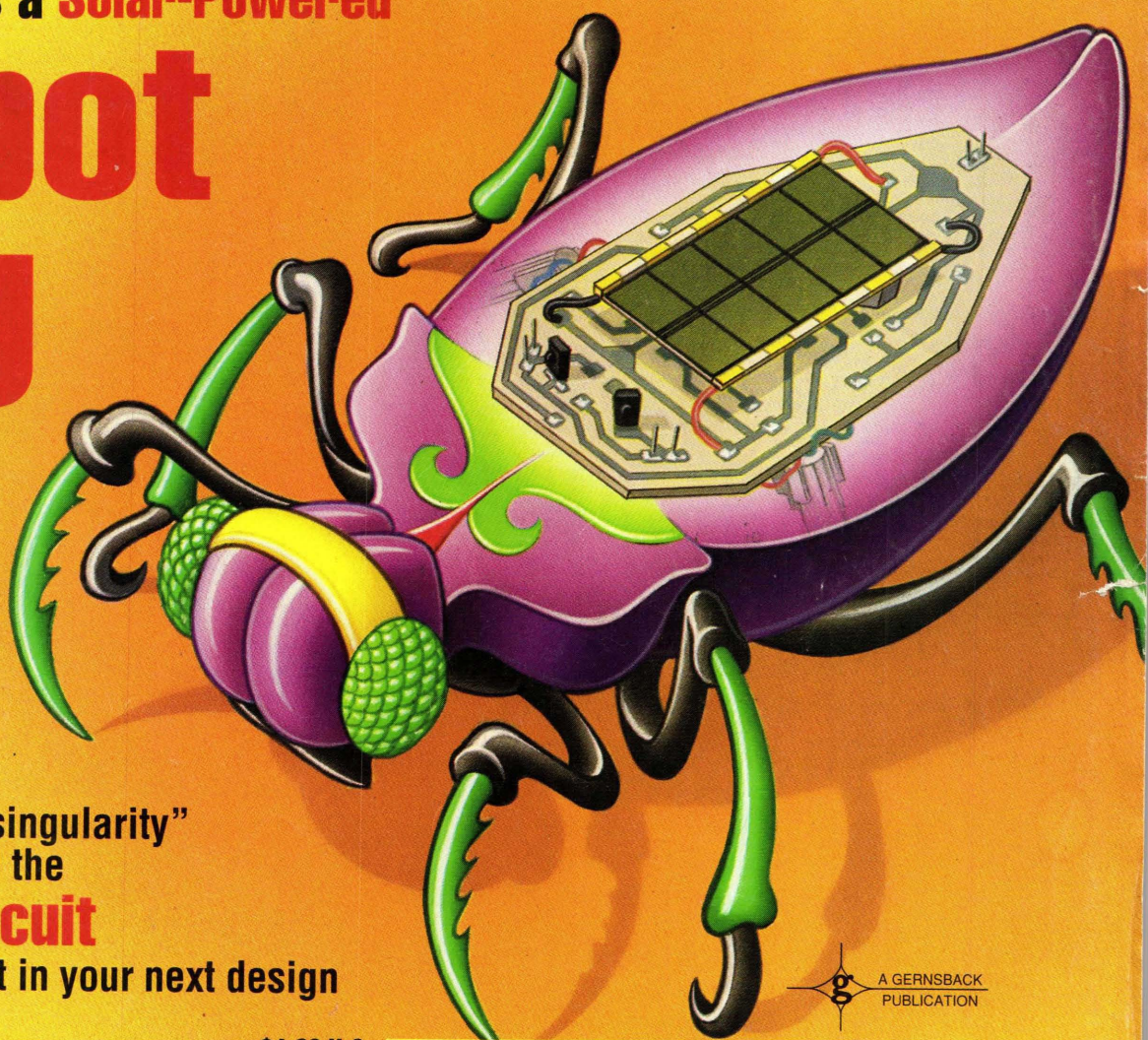
NEW TECHNOLOGY TO SNARE SMUGGLERS

Electronics NOW®

NOVEMBER 1998

It creeps, it crawls, it looks for light, it's a Solar-Powered

Robot Bug



New technology for cars could some day mean

No More Accidents

Learn about a "singularity" sensation called the

Möbius Circuit

and how to use it in your next design

A GERNSBACK PUBLICATION

$4.99 U.S.
$5.50 CAN.

Get more out of one of our most popular recent projects when you build a

Speed Doubler For The High-Speed Logic Analyzer

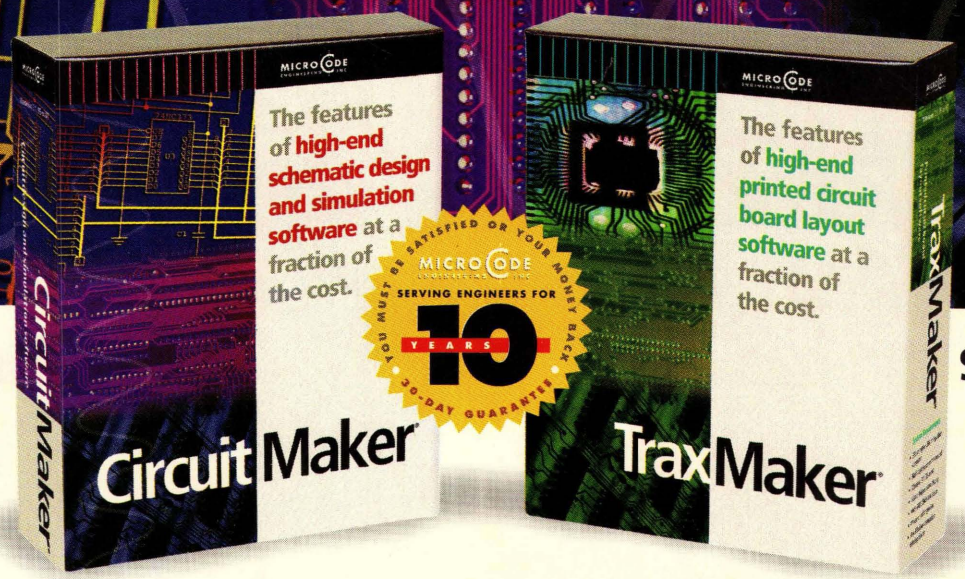
#BXNBQWF****** 5-DIGIT 54303
#LRI0424W098 2#751768 OAP73

APR 99

JOE LORITZ
424 WILSON AVE
GREEN BAY WI

05EN
54303-4115

High-end features. Low-end price.



YOU MUST BE SATISFIED OR YOUR MONEY BACK
MICROCODE
SERVING ENGINEERS FOR 10 YEARS
30-DAY GUARANTEE

$299
CircuitMaker 6: Schematic design and simulation software

$299
TraxMaker 3: Printed circuit board layout software

CircuitMaker Version 6 and TraxMaker Version 3 give you the features of professional, high-end software at a fraction of the cost. Plus, with exceptional ease-of-use you'll spend less time learning to use the software and more time designing. Both applications are compatible with your existing software, and feature outstanding technical support. Call now for your free functional demo.

CircuitMaker 6 is a powerful schematic design and simulation program featuring:

- Professional schematic features including printout borders, title block and barred pin names
- Symbol editor and Macro feature for custom devices
- Fast, accurate SPICE3f5/XSPICE-based simulation
- Complete array of analysis types, including Fourier, AC, DC, Parameter sweep, Transient and more
- Virtual instruments including a digital oscilloscope, multimeter, Bode plotter, curve tracer and more
- Extensive library of over 4,000 models
- Tight integration with TraxMaker® for quick PCB layout
- Output PCB netlists in Protel®, Tango® and TraxMaker® formats for use in a variety of PCB layout programs
- Windows 3.1, 95 and NT

TraxMaker 3 is a powerful printed circuit board layout program featuring:

- Over 2,000 component footprints in a fully-documented, indexed library. Documentation shows footprints actual size
- Built-in autorouter and Design Rules Check
- Supports up to 6 signal layers plus power and ground planes, silk screen overlays and solder and paste masks
- Board sizes up to 32" x 32", with no pin limitations
- Intelligent manual routing with unroute capabilities
- Import any PCB netlist in CircuitMaker®, Protel® or Tango® format
- Output RS274X Gerber files, Excellon N/C drill files and Bill of Materials
- Print to any Windows-compatible printer or plotter
- Windows 3.1, 95 and NT

MICROCODE ENGINEERING INC

For free demo software, or to order, call 1-800-419-4242

927 West Center Street • Orem, UT 84057 • Phone (801) 226-4470 • Fax (801) 226-6532 • **www.microcode.com**

©1998 MicroCode Engineering, Inc. All rights reserved. CircuitMaker, TraxMaker, SimCode and MicroCode are registered trademarks of MicroCode Engineering, Inc. All other brand and product names are trademarks or registered trademarks of their respective companies.

CIRCLE 133 ON FREE INFORMATION CARD

Electronics NOW

Vol. 69 No. 11

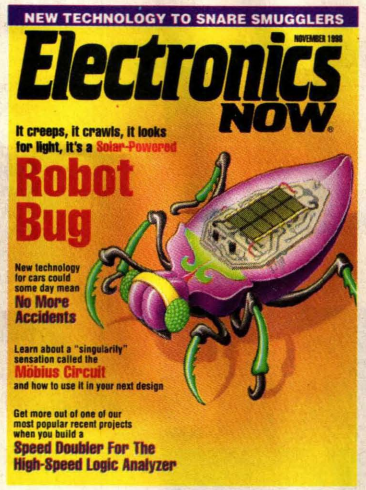
CONTENTS

NOVEMBER 1998

ON THE COVER

31 A SOLAR-POWERED ROBOT BUG

If you are a fan of science fiction, you know that the literature is full of tales of robots. In most cases, those robots are creatures that faithfully mimic the behaviors of a living creature—Man. Well, while such robots are still science fiction, robots themselves are very real and have been for some time. Most are industrial devices that perform repetitive tasks either under direct control of a person or by following a set program. But there is another, more interesting class of robot—the kind that reacts to its environment just like simple creatures do. While such robots are a far cry from the robots of fiction, if human-like robots ever become real, these robot creatures—including the subject of this month's cover story—will be remembered as their early ancestors. — *David Williams*

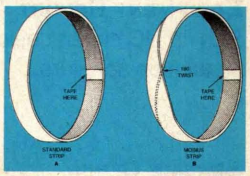


TECHNOLOGY

13 PROTOTYPE

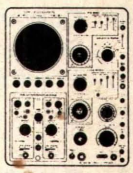
New technology to catch smugglers, ultra small computers, a lab on a chip, and more.

41 MÖBIUS CIRCUIT



The current mirror, a basic IC building block, has some interesting properties.
— *Skip Campisi*

45 FAST BUT FORGOTTEN



It's one of the fastest display devices available, yet few modern engineers have ever seen a sampling oscilloscope.
— *Tom Napier*

48 NO MORE ACCIDENTS

Here's how engineers hope to some day eliminate dangerous intersection accidents.
— *Bill Siuru*

As a service to readers, ELECTRONICS NOW publishes available plans or information relating to newsworthy products, techniques and scientific and technological developments. Because of possible variances in the quality and condition of materials and workmanship used by readers, ELECTRONICS NOW disclaims any responsibility for the safe and proper functioning of reader-built projects based upon or from plans or information published in this magazine.

Since some of the equipment and circuitry in ELECTRONICS NOW may relate to or be covered by U.S. patents, ELECTRONICS NOW disclaims any liability for the infringement of such patents by the making, using, or selling of any such equipment or circuitry, and suggests that anyone interested in such projects consult a patent attorney.

ELECTRONICS NOW, (ISSN 1067-9294) November 1998. Published monthly by Gernsback Publications, Inc., 500 Bi-County Boulevard, Farmingdale, NY 11735-3931. Periodicals Postage paid at Farmingdale, NY and additional mailing offices. Canada Post IPM Agreement No. 334103, authorized at Mississauga, Canada. One-year subscription rate U.S.A. and possessions $24.99, Canada $33.15 (includes G.S.T. Canadian Goods and Services Tax, Registration No. R125166280), all other countries $33.99. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $4.99. © 1998 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

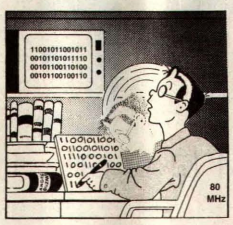
POSTMASTER: Please send address changes to ELECTRONICS NOW, Subscription Dept., Box 55115, Boulder, CO 80328-5115.

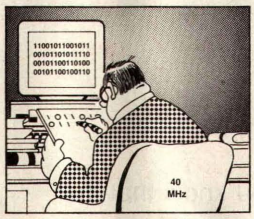
A stamped self-address envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.

NOVEMBER 1998

BUILD THIS

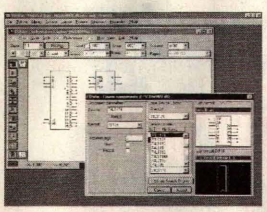
38 A Speed-Doubling Adapter For The High-Speed Logic Analyzer
Build this adapter for one of our most popular recent projects and capture samples at an 80-MHz rate.
— Robert G. Brown



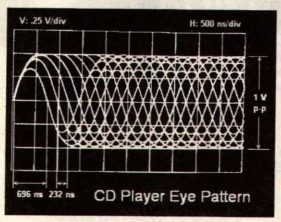


DEPARTMENTS

11 Equipment Report
EDWin NC circuit design and simulation software.



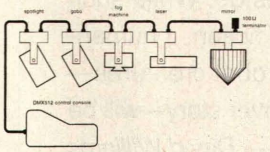
18 Service Clinic
Specific CD-player problems, interesting signals, and more.
— Sam Goldwasser



CD Player Eye Pattern

24 Computer Connections
Comparative anatomy.
— Jeff Holtzman

54 Tech Musings
Pseudoscience today, theater lighting controls, and more.
— Don Lancaster



AND MORE

4 **Editorial**
6 **Q&A**
23 **Letters**
27 **New Products**
30 **New Literature**
102 **Advertising Index**
102 **Advertising Sales Office**

Electronics Now®

Hugo Gernsback (1884-1967) founder

Larry Steckler, EHF, CET, Editor-in-chief and publisher
Adria Coren, Vice-President
Ken Coren, Vice-President

EDITORIAL DEPARTMENT
Carl Laron, editor
Joseph J. Suda, technical editor
Evelyn Rose, assistant editor
Michael A. Covington, N4TMI contributing editor
Sam Goldwasser, service editor
Jeffrey K. Holtzman, computer editor
Franklin J. Miller, audio editor
Don Lancaster, contributing editor
Debbie Cybula, editorial assistant

ART DEPARTMENT
Andre Duzant, art director
Russell C. Truelson, illustrator

PRODUCTION DEPARTMENT
Ruby M. Yee, production director
Kathryn R. Campbell, production assistant
Ken Coren, desktop production director
Melissa Giordano, desktop production

CIRCULATION DEPARTMENT
Theresa Lombardo, circulation manager
Gina Gallo, circulation assistant

REPRINT DEPARTMENT
Christina M. Estrada, reprint bookstore

Typography by Mates Graphics

Electronics Now is indexed in *Applied Science & Technology Index*, *Readers Guide to Periodical Literature*, *Academic Abstracts*, and *Magazine Article Summaries*.
Microfilm & Microfiche editions are available. Contact reprint bookstore for details.

Advertising Sales Offices listed on page 102.

Electronics Now Executive and Administrative Offices
1-516-293-3000.

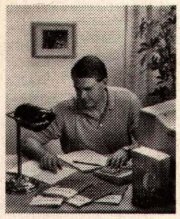
Subscriber Customer Service:
1-800-999-7139.
7:00 AM–6:00 PM Monday–Friday MST

VISIT US ON THE INTERNET AT:
www.gernsback.com

Audit Bureau of Circulations
Member

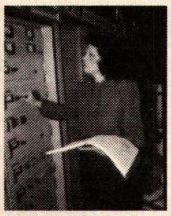
Affordable Hi-Tech Training!

Announcing New Micro Courses from the CIE Bookstore.



Easy at-home learning.
Cleveland Institute of Electronics has created a collection of micro courses that focus on our most popular subjects. Offered through our bookstore, every micro course leads to a Certificate of Completion once finished. Each course may contain up to 39 lessons with exams and many have lab exercises, training videos or software to supplement your studies. Experience a step-by-step program designed specifically for the independent study student.

Enroll now and receive student privileges that include **Instructor Assistance*, Priority Grading and Student Resources.** These privileges will allow you to access our faculty and staff if you ever need assistance with your course work and insure that your submitted exams will be graded and sent back to you within 24 hours.



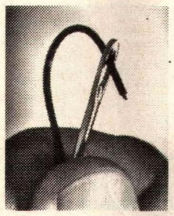
Programmable Controllers Micro Course
This course starts by explaining how a Programmable Controller (PLC) functions in an automated system. Learn about the parts of a PLC which enable it to perform its function. Look at a typical application and learn how to develop a written program for it.
01-PC01 ..... **$65**

(This micro course would make a great addition to the videos listed below. 01-567PLC)

8-Part PLC Video Training Set
Contains 4 hours of video lessons and a 146 page study guide. These easy-to-follow video lessons will make learning this vital information fast & easy. This 8-part training course is designed to take 32 hours. However, you can study at your own pace & review each lesson as many times as you need! Video set does not include certificate of completion. 01-567PLC **$169.95**

Subjects Covered In the Video Training Set:

- How process control works
- PLC advantages
- PLC disadvantages
- Identifying PLC sections
- Move functions
- How to read flow charts
- Troubleshooting techniques
- Identify logic faults
- PLC servo control
- Scanning sequence
- Timer instructions
- Counter instructions
- Output instructions
- Identify input faults
- Identify output faults
- * Plus much more!



Fiber Optics Course
Apply what you have learned in this course to install, diagnose and repair complex fiber-optic communications systems and take your place in the forefront of a fascinating and challenging new technology.

CIE Lesson & Exam Material Covers:
• Troubleshooting Fiber Optics • Characteristics of Fiber Optics • Fiber-Optic Communications Modules • Light • Laser Atomic Physics • Practical Lasers • Modulating the Laser Beam • Masters • Laser Applications • Maintenance of Lasers & Laser Systems

Video & Workbook Material:
• Understanding Fiber Optics
01-FB01 ..... **$125**

AC/DC Basic Electronics with Lab
39 lessons with lab. All this knowledge & support will put you on the road to understanding many areas of electronics.
03-INTRO **$195**

CIE Soldering Course with Lab
3 lessons with lab, soldering iron & video tape.
01-SD01 ..... **$95**

Television Diagnosis & Repair Course
12 lessons, 5 videos & technician repair software.
01-TV01 ..... **$345**

Computer Programming in C
10 lessons, text, study guide & software package
04-CET352 ..... **$275**

Database Management
6 lessons, dBASE III software (student version)
01-DB01 ..... **$195**

Computer Aided Circuit Design & Drafting with Lab
16 lab assignments, Micro-Cap III (student version) 04-CET351 ..... **$195**

Introduction to Computers
8 lessons on the basics, video. 01-IN01 .. **$195**

Automotive Electricity & Electronics Course
5 lessons, 150 piece Auto Electrical Tool Kit
01-AU01 ..... **$195**

Oscilloscope Fundamentals
Learn fundamental principles common to all oscilloscopes. 1 lesson, video and workbook. 01-SCP01...**$95**

Microprocessor Theory & Applications
Learn operation & architecture of a microprocessor. Program in machine and assembly langauge. 17 lessons, lab & video. 03-MICRO .. **$475**

FCC Exam Review Course
25 lessons to prepare you for general-class license. FCC ID software. 01-FCC01 ..... **$295**

CET Exam Review Course
1 lesson to prepare you for Associate-Level CET test. Answer practice test questions that will cover all areas of the test. 01-CT01 ..... **$65**

*Some courses include non-CIE material (videos) that will supplement your studies but will not be included under Instructor Assistance.

Start your training today!

CIE — WORLD COLLEGE

Call: 1-800-321-2155
or fax: 1-440-951-2186

Send check, money order or credit card information to: CIE 1776 E. 17th Street Cleveland, OH 44114 or call 1-800-321-2155.

Name _____

Street _____

City _____

State _____ Zip _____

Phone Number _____

Enter Micro Course Number and Price.

OH RESIDENTS ADD 7 %	
SHIPPING & HANDLING**	
TOTAL	

_____VISA _____MasterCard _____Discover

Exp. Date_____

Account Number_____

Signature_____Date_____

SHIPPING & HANDLING CHARGES:

$50.01- $100.....$10.25 $200.01- $400....$25.75
$100.01- $200...$15.75 $400.01- Over....$31.00

** Foreign shipping costs will be higher. Call for rates.

MC04

Call 1-800-321-2155 or fax 1-440-951-2186 to place an order. CIE: 1776 E. 17th Street, Cleveland, Ohio 44114. www.cie-wc.edu

Accredited B.S. Degree in Computers or Electronics
by studying at Home

Grantham College of Engineering
offers 3 distance education programs:

- B.S.E.T. emphasis in Electronics
- B.S.E.T. emphasis in Computers
- B.S. in Computer Science

NEW -Electronics Workbench Professional 5.0 included in our B.S.E.T curriculums
-Approved by more than 200 Companies, VA and Dantes, (tuition assistance avail.)

For your free catalog of our programs dial
1-800-955-2527
http://www.grantham.edu

GCE
Your first step to help yourself better your future!

DISTANCE EDUCATION AND TRAINING COUNCIL DETC ACCREDITED MEMBER

Grantham College of Engineering
34641 Grantham College Road
Slidell, LA 70460-6815

SINACO ELECTRONICS
PIC16C54 & 16C56, 16C57
GAL16V8, 20V8, 22VI0
EPROM 2764A, 256, 512
MC68HC705AC8P
62256 Static Ram . . . and much more
Tel: 818-705-1880 Fax 705-1881

ANTIQUE RADIO CLASSIFIED
Free Sample!
Antique Radio's
Largest Circulation Monthly.
Articles, Ads & Classifieds.
6-Month Trial: $20.95. 1-Yr: $40.95 ($57.95-1st Class).
A.R.C., P.O. Box 802-L21, Carlisle, MA 01741
Phone:(978) 371-0512 VISA/MC Fax:(978) 371-7129

Support
The College Fund.
Call 1-800-332-UNCF.

The College Fund/UNCF
A mind is a terrible thing to waste.
Ad Council

EDITORIAL

Try This One

Sometimes the old ideas are the best ones. For example, years (and I do mean years) ago, our predecessor **Radio-Electronics** had an occasional feature called "Try This One." In it, readers sent in their workbench tips and hints, and the best ones were published for all to see.

Well, over time and for reasons that are now long forgotten, that feature disappeared, which is truly a shame. For one thing, while not all the ideas would work for everyone, there were lots of gems that I am sure others would not have thought of on their own. Also, it gave our readers a way to feel more a part of the magazine.

For a long time, I'd been worried about a lack of reader participation in **Electronics Now**. I was not sure if it was a lack of interest, an unhappiness over our direction, or what. My editorial in the July issue (Who Are You? What Do You Want?) helped answer that dilemma: It was just that nobody at this end asked!

Well, since asking worked once (we are still getting mail), let's try again. Do you have a workbench tip or trick that you think others could use and benefit from? If so, why not send it in! What we are talking about here are things like ways of making plated-through holes on home-made boards, creating third hands or other assembly jigs to make stuffing a PC board easier, ways to take measurements in inconvenient spaces, unusual ways to use tools to do special jobs, and so on. Just about anything that could make the life of a builder, servicer, or experimenter easier is fair game.

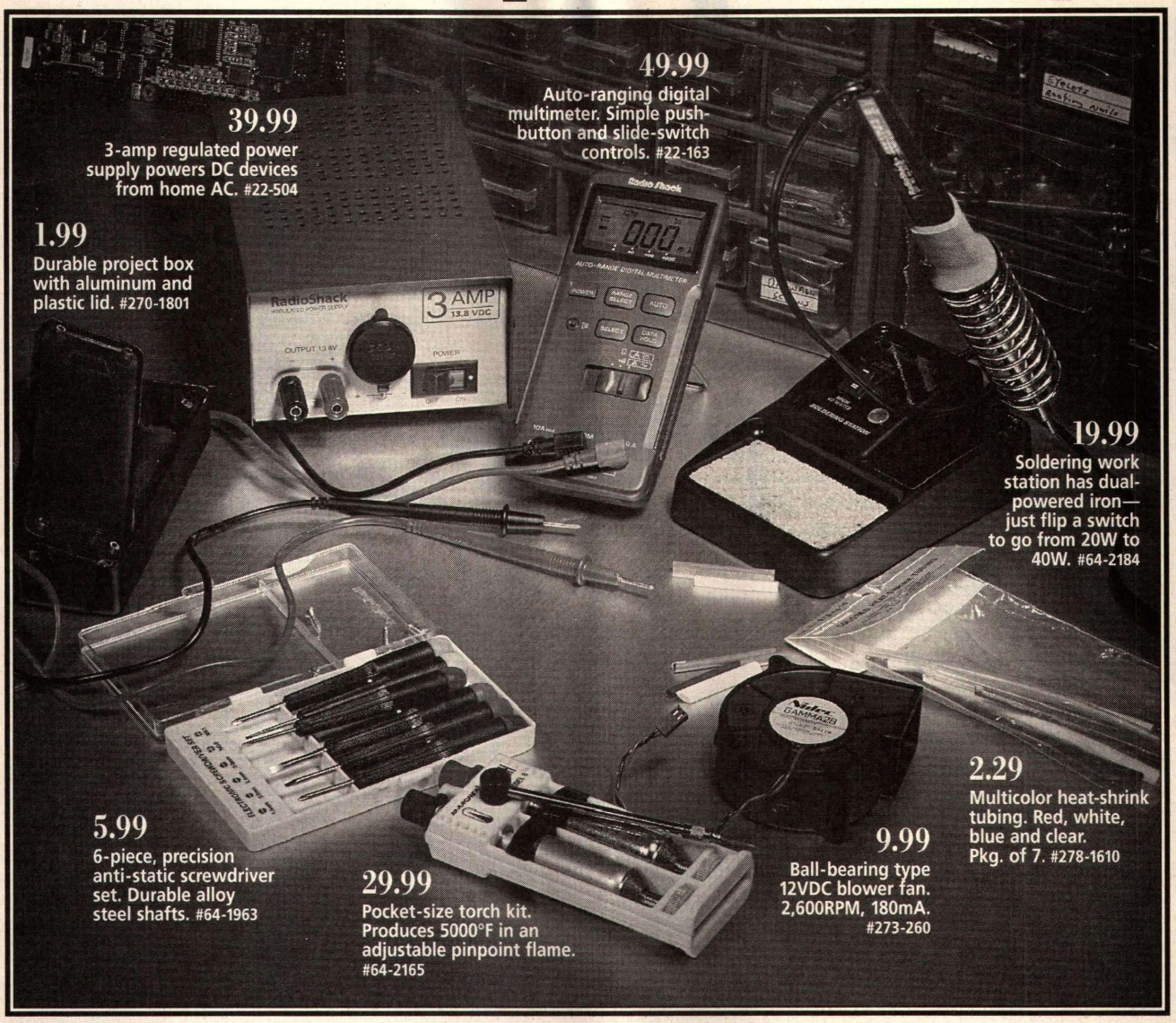
And, you might ask, what's in it for you? Well, aside from seeing your name in print and having the satisfaction of helping your fellow electronics hobbyists and professionals, we are offering a bribe! We will pay $25 for any items we use. If you include a photograph that is suitable for publication, we'll make it $50. If similar ideas are received, the one that gets here first is the one that gets the cash.

We'd really like to revive "Try This One," but whether we can or not is up to you. I'm sure that there are plenty of ideas out there that need to be spread around. All we need is people to share them with each other. Let's get to it, and thanks.

Carl Laron

Carl Laron
Editor

We're *the* shop for home shops.



Solutions for all your projects and repairs.

There's a RadioShack in your neighborhood with the tools, parts and accessories to complete virtually any small electronics project or repair. You'll find the hottest gear for everything from making simple repairs and testing circuits to building speaker systems and designing your own electronic devices. Even hard-to-find parts and accessories that might not be on our shelves are available for fast delivery direct to your door—just ask a store associate about RadioShack Unlimited. For our store nearest you, call 1-800-THE SHACK (1-800-843-7422).

RadioShack®

You've got questions. We've got answers.®

Prices apply at participating RadioShack stores and dealers. Independent RadioShack dealers and franchisees may not be participating in this ad or stock or special-order every item advertised.

CIRCLE 150 ON FREE INFORMATION CARD

Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

CONDUCTED BY MICHAEL A. COVINGTON, N4TMI

Long-Period Timer

Q *Is there any chip or simple circuit that can be used as a reliable timer for a long time delay (30 days) with good repeatability? — J. Z., Missisauga, Ont., Canada*

A Let's see, 30 days equals 2,592,000 seconds, which means you'll need to count billions of cycles if you use a crystal clock oscillator. The cheapest way is to use a microcontroller, which can count up to any number by using multiple registers. Each 8-bit register can count to 255; each time it rolls over, increment another register, and chain registers together until you can count high enough.

Off-the-shelf long-period-timer chips also exist. The 4060 includes a crystal oscillator and 14 divide-by-two stages so that it can count to 16,384; it runs on supply voltages from about 5 to 15 volts. The 74HC4060 is an equivalent device except that it requires a fixed 5-volt supply. Three of those chips in cascade, controlled by a 1.696-MHz crystal, would produce a square wave with one cycle every 30 days. Figure 1 shows a circuit using that approach. Unfortunately, we did not have a few months to spare, so we haven't tested it fully. You can get custom-made crystals from JAN Crystals, PO Box 60017, Fort Myers, FL 33906, and other suppliers.

Crystal Tester

Q *I am building a test panel and would like to include a tester to tell whether crystals are good or not. Can you help? — R. B., Langley, B.C., Canada*

A Figure 2 shows a classic Colpitts oscillator circuit that will test crystals from about 1 MHz up. The LED glows (not at full brightness) when the crystal is oscillating; for best results, use a low-current LED. You can connect a frequency counter across the LED to measure the frequency of oscillation. Note that overtone crystals will oscillate at their fundamental frequency; for example, 27-MHz CB crystals will oscillate at 9 MHz, and most scanner crystals will oscillate around 18 to 20 MHz.

Closed-Caption Decoder

Q *I've been told that the chips for decoding TV closed captions cost about $5. I know all modern TVs are required to have closed-caption built in, but in all the schematics I've looked at, the decoding is an integral part of the master processing chip. Is there a chip that can easily be added internally to older sets so that a decoder box doesn't have to be carried around and connected to different sets around the home? If so, where can I get information on the chips and associated circuitry? — J.N.B., Denver, CO*

A It isn't simple and certainly isn't a matter of a single off-the-shelf chip. You need a microprocessor that has access to

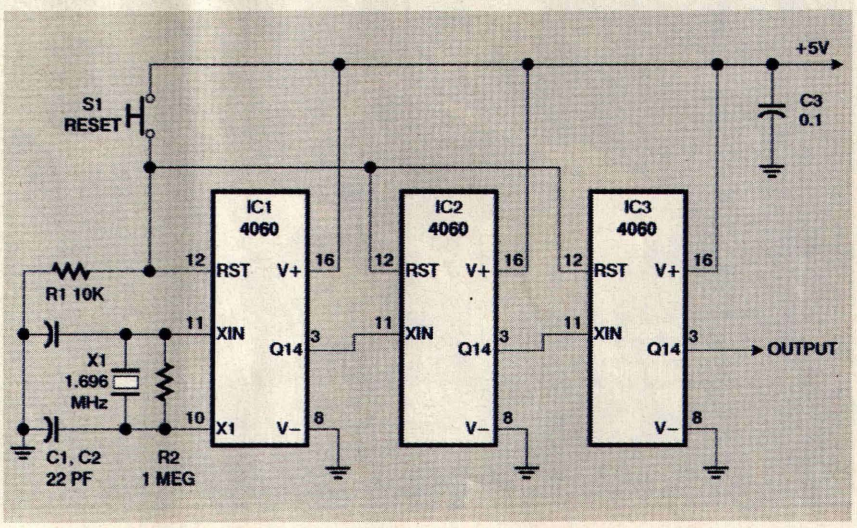


FIG. 1—THIS SUPER-SLOW OSCILLATOR produces a squarewave with a period of 30 days (one cycle per 30 days). The crystal can be ordered from the source provided in the text.

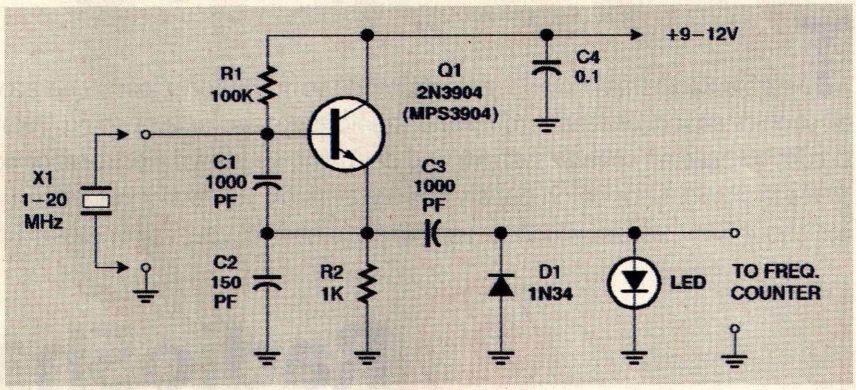


FIG. 2—THE VERNERABLE COLPITTS OSCILLATOR can be used to test crystals from 1 to 20 MHz, and even higher. If the crystal is good (oscillates), the LED will light.

the video and sync signals and the ability to generate its own video (for the lettering) in sync with what's coming in. The only reason closed-caption decoding is cheap to add to modern TV designs is that they already have such a microprocessor for other purposes, such as displaying the channel number and setup menu on the screen. So the closed-caption decoder isn't really a chip, it's some additional software in the chip that's already there.

See our December, 1994, issue, pp. 31-43, for a closed-caption decoder that sends its output to a personal computer rather than the TV screen. See also *http://www.brouhaha.com/~eric/pic/caption.html* for a circuit and the code for closed-caption decoding with a PIC microcontroller.

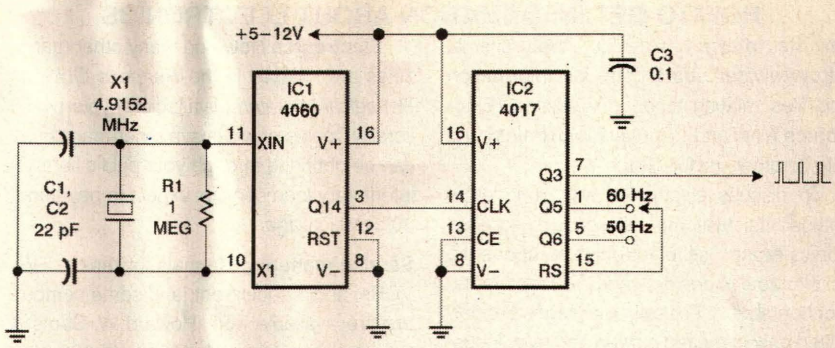


FIG. 3—THIS TWO CHIP CIRCUIT can be used to generate an accurate 50 Hz or 60 Hz clock signal using a standard microprocessor crystal.

Safe NiCd Discharge

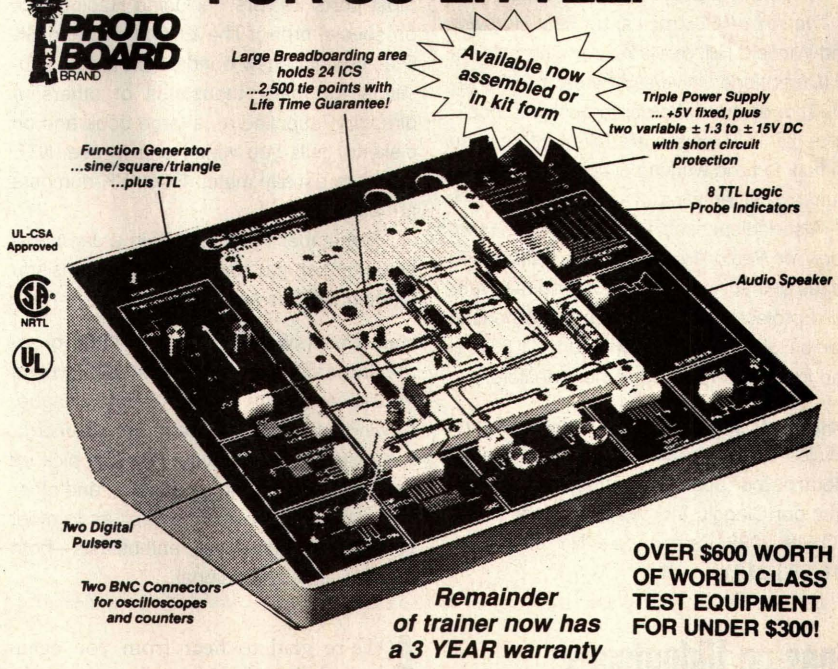
Q *I found out by accident that letting a NiCd battery pack sit unused for a long time (several months or more) safely "conditions" the power pack to accept a full charge as if it were new. In time, the cells discharge to a very low voltage without the danger of reverse-polarizing a cell, which is what might happen during deep discharging with a load. If I used a very light load (say 1 mA), would it be possible to discharge a battery pack safely without reverse-charging any of the cells? — J. A., via e-mail*

A It's well known that if you charge a NiCd battery a lot, but never discharge it deeply, its performance will suffer. On the other hand, if you discharge the battery below about 1 volt per cell, you risk reverse-charging and ruining the cells that go dead first, since current will still be flowing through them from the other cells.

Leaving a battery pack alone is a good way to deep-discharge all the cells without reverse-charging any of them, but as you've discovered, it takes a long time. Unfortunately, we know of no shortcut. When you leave the battery unused, each cell discharges through its own internal leakage without sending any current through the other cells. If you use a load, no matter how light, the current passes through all of the cells regardless of each cell's state of charge. As you surmise, very light loads are better than heavy loads, and a 1 mA load might actually be quite safe—but full discharging would still take a couple of months.

AT $299.95, NO OTHER DESIGN WORKSTATION GIVES YOU SO MUCH FOR SO LITTLE.

PROTO BOARD BRAND



Remainder of trainer now has a 3 YEAR warranty

OVER $600 WORTH OF WORLD CLASS TEST EQUIPMENT FOR UNDER $300!

The PB-503 is a total design workstation. It has everything! **Instrumentation**, including a function generator with continuously variable sine/square/triangle wave forms—plus TTL pulses. **Breadboards** with 8 logic probe circuits. And a **Triple Power Supply** with fixed 5VDC, plus two variable 1.3 outputs (+1.3 to 15VDC and –8 to 15VDC). Throw in 8 TTL compatible LED indicators, switches, pulsers, potentiometers, audio experimentation speaker...plus a lifetime guarantee on all breadboarding sockets! You have everything you need right there in front of you! PB-503—one super test station for under $300! Order yours today!!

Can't Wait! Call Toll-Free For More Information
1-800-572-1028
or the name of your local distributor
OR VISIT OUR WEB SITE AT www.globalspecialties.com
70 Fulton Terrace, New Haven, CT 06512
(203) 466-6103 • Fax: (203) 468-0060

GLOBAL SPECIALTIES

an Interplex Industries company

CIRCLE 131 ON FREE INFORMATION CARD

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League, Newington, CT 06111; (http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

Erasing Videotapes

Q *The last letter I wrote to your predecessor magazine with a question was in 1948. You were most helpful. I have another question I hope you can help me with.*

Do you have any ideas on construction of a bulk eraser for video tapes? I don't want to wear out my VCR by running each tape through it just to erase. My collection of your magazines goes way back before the invention of VCRs but I can't seem to locate a project of this type. — J. L. A., Mesa, AZ

A We're glad to hear from you again and glad to be of service to you at precise 50-year intervals. We'll expect to hear from you again in 2048.

Seriously, for readers who may not know it, **Electronics Now** is one of the oldest electronics magazines in the business; it was formerly **Radio-Electronics**, and before that, **Radio Craft**. Our founder, Hugo Gernsback, was a prominent advocate of new technology, and was also a pioneer science fiction publisher.

On videotape erasing, see this column, August 1998, page 11. The key is going to be getting the tape close enough to an AC electromagnet. You might modify a video tape rewinder to spool the tape past a bulk eraser. Driving the electromagnet with a frequency higher than 60 Hz might also help. Apparently, videotape erasing is surprisingly difficult; we'd like to hear from readers who have built tape erasers that work well.

Have LCD, Want To Use It

Q *I have a back-lighted 10.5-inch-diagonal LCD screen, a Sharp LM64C35P, from a deceased notebook computer. Can I connect it to a desktop computer as a monitor? Is a pinout diagram available? — B. M., U.S. Navy*

A You can get detailed information about Sharp display panels from *http://www.sharpmeg.com* or by contacting Sharp Microelectronics, 5700 N.W. Pacific Rim Blvd. M/S 20, Carnas, Washington 98607. Interfacing the panel to a PC sounds like a challenging project; as you surmised, it doesn't take the video signal from an ordinary VGA card, but instead responds to digital commands from the computer.

MM5369 Substitute Found

In August (pp. 12-13) we lamented National Semiconductor's decision to discontinue the MM5369AA/N IC, which produces a precise 60-Hz square wave from a 3.58-MHz color TV crystal.

Figure 3 shows a substitute. Now that 4.9152-MHz microprocessor crystals are a standard item, all you have to do is divide that frequency by 16,384 (= 2^{14}) and then by 5 to get 60 Hz. That means you can build a crystal-controlled source of 60 Hz with two chips, and if you want 50 Hz all you have to do is change one connection. The output waveform does not have a 50% duty cycle, but that's no problem if what you're doing is controlling a clock. To get precise frequency control, make one of the capacitors C1 or C2 variable. You can use 74HC chips (74HC4060, 74HC4017) if the supply voltage is 5 volts.

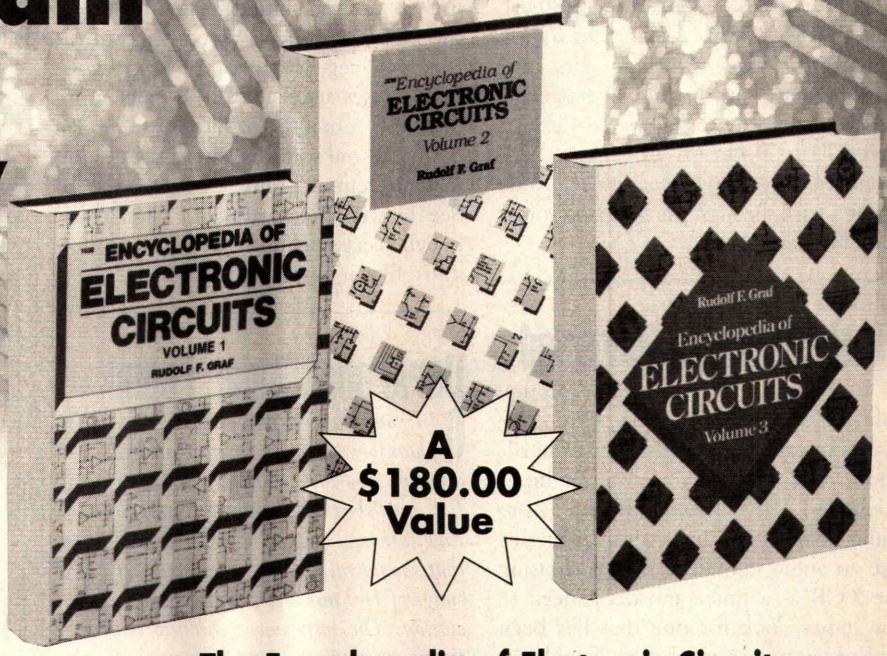
Plated-Through Holes

In the April issue, reader E. V., of Toledo, Ohio, asked how to make plat-

Take This Giant Circuit Library For Only $4.95

when you join the **Electronics Engineers' Book Club®**

"...includes schematics for the latest electronics circuits from industry leaders..."
—Popular Electronics



A $180.00 Value

The Encyclopedia of Electronic Circuits
Volumes 1-3 *by Rudolf F. Graf*
2,344 total pages • 3,490 total illustrations

Hundreds of circuit ideas alphabetically arranged—from Alarm circuits to Zero crossing detector circuits!

Turn to this comprehensive circuit library for hundreds of project ideas...valuable troubleshooting and repair tips...and concise pinout diagrams and schematics. Each volume contains more than 700 electronic and integrated circuits and covers 100+ circuit categories.

As a member of the **Electronics Engineers' Book Club...**

you'll enjoy receiving Club bulletins every 3-4 weeks containing exciting offers on the latest books in the field at savings of up to 50% off the regular publishers' prices. If you want the Main Selection, do nothing and it will be shipped automatically. If you want another book, or no book at all, simply return the reply form to us by the date specified. You'll have at least 10 days to decide. If you ever receive a book you don't want due to late delivery of the bulletin, you can return it at our expense. Your only obligation is to purchase 2 more books during the next 12 months, after which you may cancel your membership at any time. And you'll be eligible for FREE BOOKS through our Bonus Book Program.

Publisher's price shown. © 1998 EEBC

If coupon is missing, write to:
Electronics Engineers' Book Club®
A Division of *The* ***McGraw-Hill*** *Companies*
P.O. Box 549, Blacklick, OH 43004-0549

Phone: 1-614-759-3666
(8:30 am to 5:00 pm EST Monday-Friday)

Fax: 1-614-759-3749
(24 hours a day, 7 days a week)

Internet: www.bookclubs.mcgraw-hill.com

ELECTRONICS ENGINEERS' BOOK CLUB®

A Division of *The* ***McGraw-Hill*** *Companies*, P.O. Box 549, Blacklick, OH 43004-9918

❑**YES!** Please send me *The Encyclopedia of Electronic Circuits-Vols. 1-3* (5857863), billing me just $4.95, plus shipping/handling & tax. Enroll me as a member of the **Electronics Engineers' Book Club** according to the terms outlined in this ad. If not satisfied, I may return the books without obligation and have my membership cancelled.

Name _____

Signature _____
(Required on all orders)

Address/Apt.# _____

City _____ State _____

Zip _____ Phone _____

Valid for new members only, subject to acceptance by EEBC. Canada must remit in U.S. funds drawn on U.S. banks. Applicants outside the U.S. and Canada will receive special ordering instructions. A shipping/handling charge & sales tax will be added to all orders.

RPIF1198M

ed-through holes on a two-sided printed circuit board. Several readers wrote to recommend various kinds of eyelets or rivets. Brian M. Meyers of Greensboro, NC particularly recommends eyelet kits available from T-Tech, Inc., 5591-B New Peachtree Rd., Atlanta, GA 30341, Tel: 770-455-0676, Web: http://www.ttech.com. One of their kits, the "Copperset," produces an especially faithful imitation of a plated-through hole. Eric Dod, of Sunnyvale, CA, points out that all you really need to do is put a wire through the hole and solder it on both sides.

TV Headphones Revisited

Responding to the April column, John H. Markell, of Sun City, CA, points out that the best source of headphone audio for a TV viewer is a high-fidelity VCR; it's designed to connect to audio systems and has output jacks just like an audio tape deck. If you're using the VCR as a tuner and don't need to play tapes, look for one that has been junked because of mechanical problems; you may be able to get one for the asking. Even ordinary (non-high-fidelity) VCRs usually produce better sound than TV sets.

LCD Conductive Strips

In the May issue, W. B. H., of Knoxville, TN, asked about a source of replacements for the special layered conductive rubber strips used in a digital multimeter to connect the LCD display to the circuit board. Edward Mulvaney, of Pasadena, CA, advises us that these are made by Fujipoly, 365 Carnegie Avenue, Kenilworth, NJ 07033, Web: http://www.fujipoly.com—but the ones in your multimeter are probably custom-made and the instrument manufacturer is the place to start.

Tom Pearson, of Ogallah, KS, says his Fluke multimeter has the same problem—the conductive strips lose their connection with the circuit board and/or display, and the display goes bad. But he doesn't have to replace the strips. Instead, he cleans them with a cotton swap moistened with rubbing alcohol, taking care not to get alcohol into the LCD. Thanks to everyone who wrote in!

HP Calculator = IR Remote Control?

In the June issue a reader asked if a Hewlett-Packard palmtop computer could use its infrared output device to mimic the signals from a TV remote control. Reader Greg Stanforth, of Lexington, KY, advises us that HP-48 calculators definitely can; if the palmtops use similar hardware and software, they may be able to emit remote-control signals as well. See Hewlett-Packard's FTP site, ftp://hpcvbbs.external.hp.com/dist/hp48g/comms, files ir_samp.zip and rem33bg.zip.

Darkroom Timer Found

Q *In your April issue, a reader asked for plans for a darkroom timer with red LED displays. My book, Build Your Own Home Lab, published by Howard W. Sams (Prompt Publications), contains a construction project that should meet the requirements. It has a range of 100 minutes with a one-second resolution. The instrument can function as a timer or stopclock. — Clement S. Pepper, Janesville, WI*

A Thanks for writing. Readers should be able to order your book through any bookstore (ask them to look it up in *Books In Print*) or by contacting the publisher at 800-428-7267 (800-428-SAMS).

IC Data on CD-ROM

Q *Where can I find data such as pinouts, circuit diagrams, and descriptions of CMOS, TTL, and linear ICs? Is this information published on CD-ROM? — X. Y., Trenton, NJ*

A Yes. Most IC manufacturers now publish data sheets on CD-ROM, and they give away the CDs or sell them for a small price. Among the most useful CD-ROMs are those from Texas Instruments (P.O. Box 655303, Dallas, TX 75265; Web: www.ti.com; Tel: 972-644-5580) and National Semiconductor (Technical Communications Dept., MS 16-300, PO Box 68090, Santa Clara, CA 95052-8090; Web: www.nsc.com).

Virtually all IC manufacturers also publish data sheets on the World Wide Web. You can locate any manufacturer by going to the search engine at www.yahoo.com and typing the company's name. Even better, there's a huge directory of all manufacturers' ICs, indexed by type number, at www.chipdir.com.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication) and give your full name and address (we'll only print your initials). Write to Q&A, **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. *If you are asking about a circuit, please include a complete diagram.* Due to the volume of mail, we regret that we cannot give personal replies. EN

THE COLLECTED WORKS OF MOHAMMED ULLYSES FIPS

#166—By Hugo Gernsback. Here is a collection of 21 April Fools Articles, reprinted from the pages of the magazines they appeared in, as a 74-page, 8½ × 11-inch book. The stories were written between 1933 and 1964. Some of the devices actually exist today. Others are just around the corner. All are fun and almost possible. Stories include the Cordless Radio Iron, The Visi-Talkie, Electronic Razor, 30-Day LP Record, Teleyeglasses and even Electronic Brain Servicing. Get your copy today. Ask for book **#166** and include **$16.00 (includes shipping and handling)** in the US (First Class), Canada and Overseas (surface mail), and order from **CLAGGK Inc., P.O. Box 4099, Farmingdale, NY 11735-0793.** Payment in US funds by US bank check or International Money Order. Allow 6-8 weeks for delivery. MA05

American Heart Association℠
Fighting Heart Disease and Stroke

Research gave him a future

Support Research

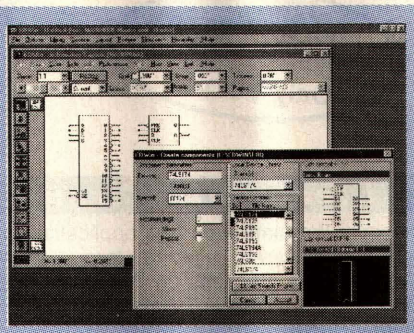
©1995, American Heart Association

EQUIPMENT REPORT

EDWIN NC CAD/CAE SOFTWARE

Design circuits from scratch to finished product on your PC with EDWin NC

CIRCLE 15 ON FREE INFORMATION CARD



The core of this magazine's coverage, and the main interest of most who read it, is electronics circuitry. Most readers have tried their hand at building at least a basic circuit, and many are accomplished builders. And even those who have never picked up a soldering iron like to look at the circuits and try to figure out how they work.

Another large segment of readers are those who like to design their own circuits. These are generally electronics professionals or advanced hobbyists with years of experimentation under their belts. This group of people is quite familiar with the tools of the trade: data books, notebook paper, pencils, erasers, breadboards, components, desoldering equipment, and so on.

The one good thing about circuit design is that it has become easier and more accessible thanks to the personal computer. The reason for that is the wide variety of Computer Aided Design/Computer Aided Engineering (CAD/CAE) software packages now available. The downside is that high-end CAD/CAE software is usually priced beyond the means of most hobbyists. However, we've found a product that is not; we'd like to tell you about it.

EDWin NC

EDWin NC, short for Electronic Design for Windows—Non Commercial, is a CAD/CAE software package that provides everything one needs to capture electronic circuits in the form of schematic diagrams and printed-circuit board layouts. The software even generates final documentation for manufacturing PC boards.

While EDWin NC from Visionics, a leading British software vendor, is far more than a hobbyist-level product, it is available to hobbyists at a hobbyist-level price. In fact, this is an engineering-level software package that normally costs thousands of dollars. But it is available to students, teachers, and amateurs for non-commercial use at just 10% its normal price—only $149.95. A $279.95 package includes EDWin NC plus EDSpice simulation software, SPICE code-development kit, and thermal-analysis software. Volume discounts are available.

EDWin NC is powerful software, but it does not require a state-of-the-art computer system. Minimum system requirements are a PC-compatible 386 or better with 8 MB of memory, 40 MB hard-disk space, an SVGA color monitor, Windows 3.1 or higher, and a mouse. Of course the faster the system, the happier you'll be with EDWin's performance.

EDWin integrates five circuit-design modules: Schematic Capture, Layout Design, Postprocessing, Simulation, and Library Editor. Users can capture circuits as schematic diagrams or as PC-board layouts. Schematic Capture and Layout Design are linked together so that changes to one affect the other, and vice versa. That way both parts of a circuit can be built simultaneously. Various tool sets are provided for each operation.

Schematic Capture involves placing parts on a snap-to page and making the appropriate circuit connections. Component outlines and pin-out data can be created by the user or pulled from the included libraries of parts. Connections between components (the netlist) are made by routing "smart" wires accordingly. Components must be laid out as devices, while other parts of a circuit are represented as symbols. For example, while +5V and GND mean something to the circuit designer or builder, they are generally not physical items placed on a circuit board. As such they do not get placed on a layout or added to a parts list.

The Layout Design module creates layouts for components consisting of silk-screens and component footprints, a netlist, and trace routing. All component and netlist information is automatically transferred from the schematic diagram to the circuit layout. Components are automatically placed with proper pin clearance and connections. Any changes made to the netlist or components on the PC-board layout are automatically transferred to the schematic. That allows board outlines from AutoCAD to be imported as .DXF files.

The Postprocessing module converts the circuit layout into data for manufacturing PC boards: artwork and documentation printouts, outputs for photo plotting, and Numerically Controlled (NC) drilling information. The Simulation module can validate circuit operation during Schematic Capture or Layout Design before actually building the circuit. The Simulation module has a Diagram Generator that graphically presents the simulated results, a Mixed Mode Simulator for AC and DC circuit analysis, an EDSpice Simulator for SPICE simulation, and a Thermal Analyzer for simulating temperature effects on a working circuit.

Even though the parts libraries bundled with EDWin NC are quite extensive, EDWin NC's Library Editor module lets users create new elements and edit ele-

ments that are already included in the bundled parts libraries. Elements can consist of device descriptions, schematic symbols, layout symbols, and so on. A library viewer lets users inspect the contents of the part libraries and make cross references between components.

Each module is activated from dropdown menus on EDWin's main screen. EDWin is packed with help files that pop up whenever a new action is initiated, so it is not difficult to learn how to use EDWin. However, as mentioned before, this is no hobbyist-level product, so there is no software wizard that will automatically design circuits. The user has to know what he's doing or else EDWin will be of little help. It definitely takes some time to become familiar with the software.

As involved as EDWin might be, such is the business of circuit design. EDWin NC is simply a product that can speed up the circuit-design process and make it far more convenient for the designer. However, when it's available at hobbyist-level prices, EDWin NC is the perfect software bundle for that budding engineer in all electronics hobbyists. The bad part is that once a hobbyist gets good enough at circuit design to make money at it, they will have to pay full price for EDWin.

For more information on EDWin NC, contact the US distributor (Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; Tel: 800-831-4242; Web: www.jameco.com); visit the Visionics Web page (www.visionics.a.se); or circle 15 on the Free Information Card. EN

Timid about getting on the. . .
World Wide Web?

You've heard about the *Information Superhighway* and all the hype that goes with it! Sort of makes you feel timid about getting on the Web. Put your fears aside! A new book, ***The Internet and World Wide Web Explained***, eliminates all the mystery and presents clear, concise information to build your confidence. The jargon used is explained in simple English. Once the tech-talk is understood, and with an hour or two of Web time under your belt, your friends will believe you are an Internet guru!

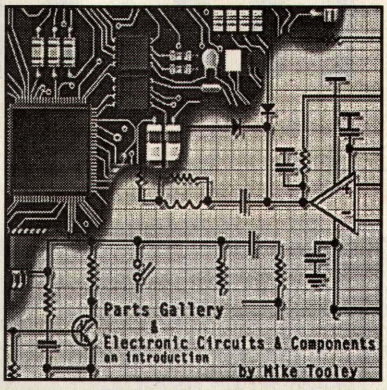
To order Book #BP403 send $10.95 plus $4.00 for shipping in the U.S. and Canada only to Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery.

BUY BONDS

NEW! ELECTRONICS CD ROM

The most effective way of learning electronics

Two Courses on one CD ROM!
Only $56.00



Electronic Circuits and Components

Discover the standards and application of common types of electronic components and how they are used to form complete circuits in ***Electronic Circuits and Components***. Sections on the disk include: Fundamental Electronic Theory, Active Components, Passive Components, Analog Circuits and Digital Circuits. The CD ROM includes:

• Interactive laboratories • Supervisor notes
• Full audio commentary • Editable worksheets
• About 20 links to pre-designed Electronics Workbench circuits

The Parts Gallery

Many students have a good understanding of electronic theory but still have difficulty in recognizing the vast number of different types and makes of electronic components. ***The Parts Gallery*** has been designed to help overcome this problem; it will help students recognize common electronic components and their corresponding symbols in circuit diagrams. This CD ROM incorporates a quiz so that students can check their knowledge of electronic components and symbols. The CD ROM includes:

• Over 150 component and circuit photographs • Supervisors notes
• Self-test Component and Symbol quizzes • Hundreds of electronic symbols

To Be Released Soon!

A series of interactive CD ROMs provides a comprehensive and up-to-date introduction to the world of electronics. The series provides a sound understanding of the principles and behavior of electronic components and the circuits to which they are connected. Two new CD ROM disks are to be released in the very near future. They are ***Analog Electronics*** and ***Digital Electronics.*** As soon as they are released, information on their contents and availability will be published.

Claggk Inc., PO Box 4099
Farmingdale NY 11735-0792
e-mail: *claggk@poptronix.com*

Name _____ Phone _____
Address _____
City _____ State _____ Zip _____

Enclosed is **$56** for each Student version of ***The Parts Gallery*** and ***Electronic Circuits & Components*** on a single CD ROM, shipping included inside the U.S. Shipping costs to Canada an additional $3.00. Overseas orders please contact CLAGGK, Inc. for shipping costs.

I am ordering (....) copies at $56 each. NY State residents must include sales tax.

[ ] I have enclosed my check for $_____
[ ] Please charge my credit card for $_____
[ ] Visa [ ] MasterCard [ ] Discover Expiration Date: ___/___
Card Number _____ Signature _____

(Name on order and signature must be same as on Credit Card.)

Prototype

Using Electronics To Beat Smugglers

Many experts believe that the collapse of the Soviet Union has made the world an even more dangerous place. That's because illicit material is being smuggled across the borders of the former Soviet Union and its former satellites on their way to rogue nations attempting to build nuclear and chemical weapons. Because of very limited funding, poorly trained inspectors, and lack of detection equipment, much of this dangerous stuff is now reaching its intended destination. Fortunately, the U.S. government is working hard to stop the flow of materials that represent a future threat to the entire world.

For instance, the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) in Richland, WA is developing advanced electronic devices to help border inspectors uncover the smuggling of various material that are needed in the construction of weapons of mass destruction. The devices can also be used to detect more benign smuggled goods from jeans to drugs.

One of these devices is the Ultrasonic Pulse Echo Detector, a hand-held unit that contains a sensor head and a computer. With the device, an inspector can determine the contents of sealed containers, measure how full a container is, and find any cavities or hidden packages—which might hold drugs or other smuggled goods—within the container.

The sensor, which transmits ultrasonic pulses and detects any return echoes, is placed on the outside wall of the container. As sound waves are transmitted, the return echoes bouncing off the other side of the container are analyzed in terms of time of transit and amplitude decay to identify the characteristics of the contents and compare those features against information in a database library. The Ultrasonic Pulse Echo Detector was originally developed by the PNNL for inspecting chemical weapon stockpiles in Iraq after the 1991 Gulf War.

THE MATERIAL IDENTIFICATION SYSTEM is shown at the left attached to laptop computer. The engineer is holding the Ultrasonic Pulse Echo instrument.

A Metal Detector

Another device used to keep dangerous goods from reaching the wrong hands is the Material Identification System, which uses eddy currents to detect strategic metals that could be used in making nuclear weapons. Most metals, including those used for strategic purposes, are similar in appearance. Therefore, it is virtually impossible for inspectors to determine what a metal is just by looking at it.

The Material Identification System uses a hand-held probe that is connected to an ordinary laptop computer via a plug-in instrument card. When the probe is passed over the suspect metal, the instrument measures the flow of electrical, or eddy, currents through the metal. Eddy currents flow through different metals in distinctive ways. The system takes advantage of that fact and uses a computer to compare and reconcile the measured flow against an extensive U.S. Customs material database to determine whether the metal is, in fact, what it is declared or purported to be, as well as determine the most likely identity of the metal. The inspector can also search the database for additional information including the classification of the metal and applicable regulations.

As a demonstration of the device's capability, it can distinguish between nickels, dimes, and other coins. Besides detecting strategic metals for nuclear

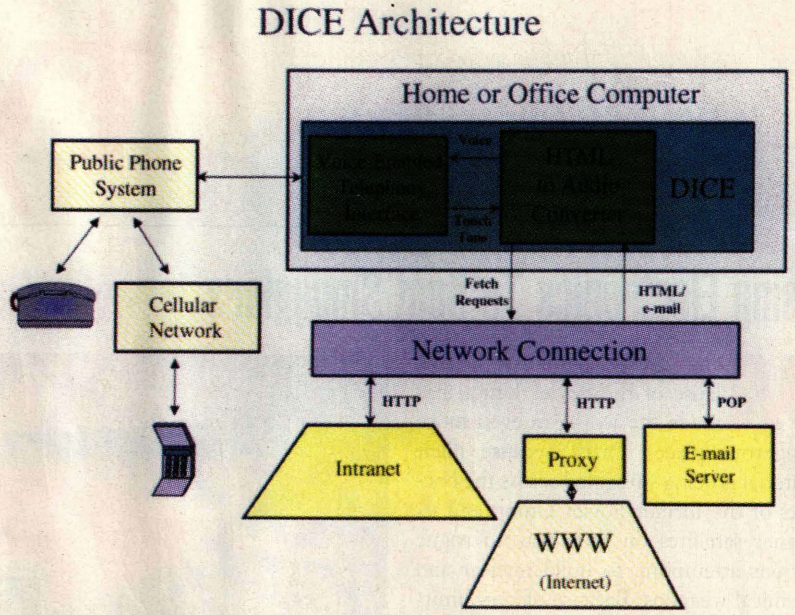
FOR MORE INFORMATION

Pacific Northwest National Laboratory
PO Box 999
Richland, WA 99352

weapons, border inspectors can use the Material Identification System to determine if a shipment of metals has been labeled fraudulently to avoid a higher duty fee.

Both pieces of detection gear, which the PNNL recommends be used together for a "one-two punch" for most effective border security, are already in use. For instance, the Ultrasonic Pulse Echo device is currently being used by the U.S. Customs Service, and the U.S. On-Site Inspection Agency recently ordered 10 sets of the equipment for use at borders in the former Soviet Union and Eastern Europe. Cypress, Malta, and several other countries have also requested both units.

Use of the new devices will also be included in the curriculum of the new Hazardous Materials Management and Emergency Response (HAMMER) training facility at PNNL's Hanford, WA site. There U.S. Customs Service and PNNL will train foreign border-enforcement officials to stop smugglers. The course, which will start this fall, includes a simulated international-border crossing and is located amid the sand and sagebrush of the southeastern Washington desert. The first "students" will come from Hungary and Slovakia.—**Bill Siuru** PT



USING ANY TOUCH-TONE TELEPHONE, including a cellular, the DICE system analyzes e-mail and HTML documents, and then plays them back as audio.

Keep In Touch—Any Time, Anywhere

A prototype system developed by scientists at Siemens Corporate Research, Inc. (SCR) allows e-mail messages or World Wide Web pages to be accessed without a laptop computer. The DICE (Delivering Information in a Cellular Environment) system uses a computer algorithm to analyze e-mail and HTML documents, and then play them back as audio over any touch-tone telephone, including a cellular. DICE uses speech synthesis tools, which convert text to audio.

A unique feature of DICE—SCR has three patents pending—is that its algorithm also analyzes the format and layout elements of a document. The system communicates both the text and structure of a document. Even highly structured HTML documents can be converted to an audio format without confusing the listener.

Using the touch-tone keypad of any telephone, callers dial a service provider, either their own home or office PC. Users can access Web pages from a list of selected bookmarks, and also retrieve e-mail by simply pressing a few keys and listening. DICE also provides a fully-functional touch-tone-based browser. Over the phone, users can follow hyperlinks, use a history list, or access standard audio features such as fast forward, rewind, or pause.

A caller can surf a favorite newspaper's Web page and hear the headlines. If there is a particular article he wants to hear, the caller simply presses a button and listens; the system retrieves the new page and plays it in real time. Pressing another button instructs DICE to remember the page for later viewing on a computer.

"For many who are on the go but don't have access to a computer, DICE enables one to retrieve and answer e-mail messages away from the office, whether driving to work, on a plane, or at the poolside," says Arding Hsu, department head, Multimedia/Video Technology. Dr. Hsu explained that once having listened to the message, one can respond by keying in a number on the phone to record a voice message. "We're working on converting the verbal response back into an e-mail message at the other end, and should support this feature soon," he said.

The system was developed by SCR scientists Michael Wynblatt, Stuart Goose, and Dan Benson in cooperation with Siemens AG's Private Communication Systems. Another similar project called WIRE (Web-based Interactive Radio Environment) is under development. It will enable drivers to access e-mail and Web sites using a driver information system rather than a telephone. SCR is working with Siemens AG's Automotive Systems Group to develop a prototype system based on this technology. PT

Ultra-Small Computers?

A team of scientists from the Georgia Institute of Technology recently observed ballistic conductance—a phenomenon in which electrons pass through a conductor without heating it—at room temperature in multi-walled carbon nanotubes up to five microns long. (A micron is a millionth of a meter.)

"This is the first time that ballistic conductance has been seen at any temperature in a three-dimensional system of this scale," said Dr. Walter de Heer, a professor in Georgia Tech's School of

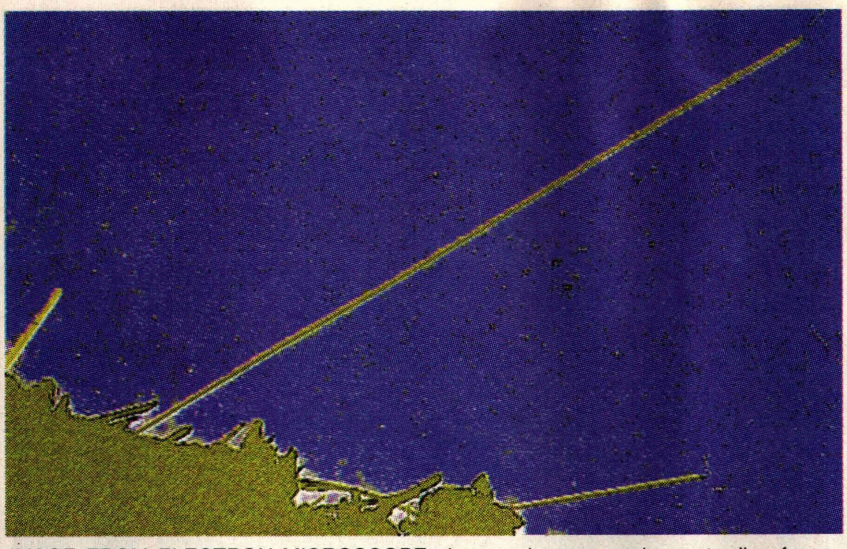


IMAGE FROM ELECTRON MICROSCOPE shows a long nanotube protruding from a bundle of nanotubes. Resistance was measured in the long tube.

Physics. "There would be interest in this for ultra-small electronics, because it shows that you can constrain current flows to narrow areas without heating up the electronics. It also introduces a new stage of electronics in which the wave nature of electrons becomes important."

Using the positioning equipment of an atomic-force microscope, researchers found that the electrical resistance of the nanotubes remained constant—regardless of their length or width. This quantum conductance is not seen in larger structures.

"In classical physics, the resistance of a metal bar is proportional to its length," said Dr. Z. L. Wang, a professor in Georgia Tech's School of Materials Science and Engineering. "If you make it twice as long, you will have twice as much resistance. But for those nanotubes, it makes no difference whether they are long or short because the resistance is independent of the length or the diameter."

In the laboratory, de Heer, Wang, and collaborators Stefan Frank and Phillipe Poncharal attached a tiny electrode to a bundle of nanotubes that had a single long tube protruding from one end. They mounted the bundle in place of the probe normally used in an atomic force microscope and connected a battery to the electrode.

They used the microscope controls to raise and lower the single protruding nanotube into and out of a pool of mercury that completed the circuit back to the battery. The resistance they measured as the nanotube was raised and lowered into the mercury remained constant, changing only when a shorter tube protruding from the bundle—which resembles a handful of straw—made contact with the liquid metal.

Researchers measured the resistance of 20 nanotubes of different lengths and diameters through as many as 1000 cycles that consisted of dipping them in and out of mercury and two other molten metals—gallium and Cerrolow-117. The tubes averaged 15 nanometers wide and four microns long, but ranged from one to five microns in length, with diameters from 1.4 nanometers to 50 nanometers. The quantum of resistance remained 12.9 kiliohms.

That's possible, explained de Heer, because the electrons act more like waves than particles in structures whose size approaches that of the wavelength of electrons. "The electrons are passing through these nanotubes as if they were light waves passing through an optical waveguide," he said. "It's more like optics than electronics."

In normal wires, the electrical energy they carry dissipates in the conductor, but in the nanotubes, energy dissipates only in the leads used to connect the tubes. Such effects had previously been seen only in structures a thousand times smaller, and finding them in the comparatively large nanotubes was quite surprising.

The absence of heating allows extremely large current densities to flow through the nanotubes. Wang and de Heer measured current densities greater than ten million amps per square centimeter—far greater than could be handled by any other conductor. Normal resistance heating would have generated temperatures of 20,000 K in the nanotubes, well beyond their combustion temperature of 700 K.

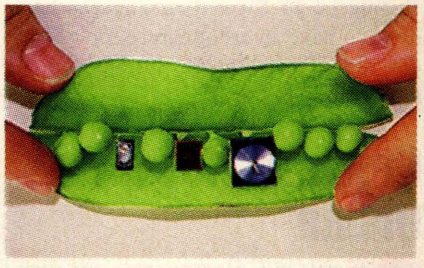
At more than five microns, however, de Heer believes electron scattering may defeat the ballistic conductance effect. "We can only guarantee that we can carry that kind of current over five microns," he said. "We don't know what will happen if you try to conduct for longer distances. This will certainly not be a way to transport current over large distances."

Electronic devices using nanotube conductors are perhaps decades away. One fundamental issue is that carbon materials are incompatible with the silicon that is the basis of current integrated circuits. Solving that challenge will require a revolution in electronic design.

"This just opens the door; it doesn't tell you how to build a better world," de Heer said. "This should be seen as the proof of principle showing that we can do ballistic conductance at room temperature." PT

Lab on a Chip

Imagine bands of tiny vehicles that cooperatively sniff out suspicious or threatening chemicals or even land mines. About 40 scientists and engineers at Sandia National Laboratories have been researching such technology. Within three years, they hope to demonstrate a device about the size of a palm-top computer that can sniff explosives and chemical warfare agents. In



THE THREE MAIN COMPONENTS OF Sandia's micro-chem lab for gas-phase detection and analysis are small enough to fit easily inside a snowpea pod.

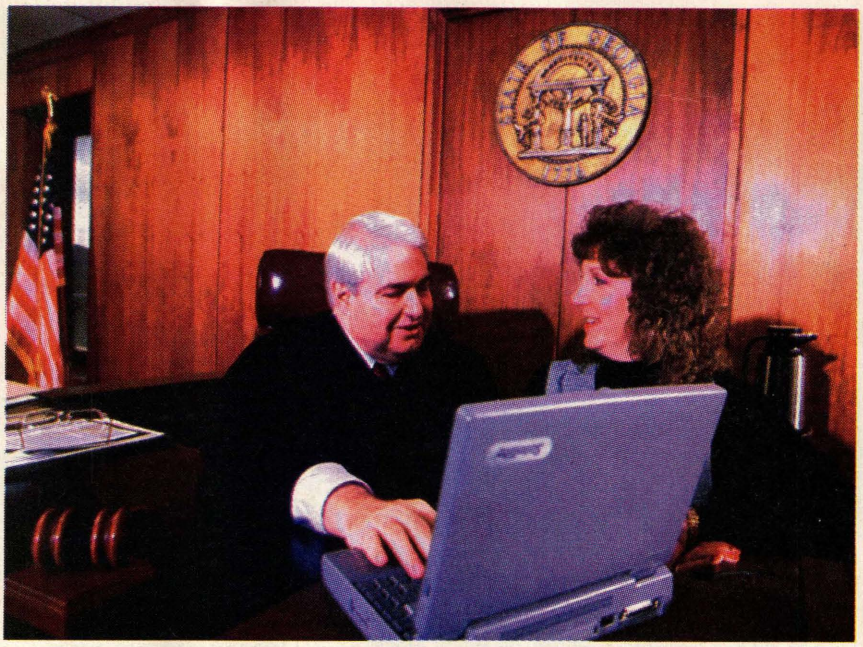
five to ten years, devices should be able to simultaneously identify hundreds of liquids and gases.

Arrays of these chemistry labs-on-a-chip could be sent onto battlefields or mounted near factories to provide chemical reconnaissance. Potential national security applications range from detecting weapons of mass destruction to monitoring the state of the nuclear stockpile. Devices might one day become available at local stores to test water and food, to monitor the course of an illness, or to determine the safety of the environment.

"There's a huge amount of information in chemical signatures that the world is not making use of," says Sandia chemist David Rakestraw, "because it's too costly. It's also very difficult to extract out all of this information using any traditional analytical chemistry in a laboratory."

Research to create an autonomous micro-chemistry lab involves exploring science in a microdomain where properties can run counter to normal intuition. For instance, liquids experience no turbulence as they move along channels smaller than a hair. Gas detection also would work differently. First, a sample would be gathered on a microporous film, then heated to vaporize. The tiny pulse of gas would then flow into a long, coiled column for separation. From there, separated gases would flow over an array of coated acoustic-wave sensors. Different absorptions by the different coatings (signaled by a shift in frequency) would build up a fingerprint characteristic of each chemical.

Sandia researchers are also creating cooperative, distributed sensing, and behavior systems. Sensors in fixed spots or on swarms of small, smart vehicles known as robugs could communicate and map the location of suspicious chemicals. In three years, researchers hope to have an architecture for what a distributed intelligence system should look like. PT



JUDGE FULLER AND LISA SILLS LOOK AT A LAPTOP that is accessing Georgia court information on the new database she designed.

Criminal Records Online

Officials in Georgia's state, superior, and juvenile courts are using the latest in information technology to help put a lid on crime. This summer, several Georgia counties gained online access to a new management information system that enables them to systematically pool information about criminal activity and other court-related matters.

Although the Georgia Crime Information Center (GCIC) already maintains an electronic database, its information is focused on sentencing and dispositions. The new database goes beyond that, making a wealth of case-related data readily available to Georgia court officials via the Internet.

Designed by senior research scientist Lisa Sills and her team in the Information Technology and Telecommunications Laboratory at the Georgia Tech Research Institute (GTRI), the database is comprised of a TCP/IP network that can be used any place with Internet access by account holders—primarily judges and clerks. It is a highly complex project that has been in the works for two years. With the new database, officials will be able to obtain more complete information about a suspect's record. For example, the database would quickly reveal if a suspect arrested by one county is under warrant for arrest in another county, alerting intake officers not to let that person out on bail.

The database is split into two major sections: one for juvenile court and one for state and superior courts. Information can be tracked either by a case docket number or by name. Under case history, the database indicates whether a bench or jury trial was held, specific events of the trial, outcome, and any changes in original sentencing. Entries for individuals also include date of birth, gender, known aliases, and a complete record of charges.

The juvenile section tracks dates of foster care along with "interested persons," including parents, guardians, and attorneys. The database also tracks gang information, which is becoming increasingly important.

Sills explained that all the information had to be imported from existing county systems, which required an automated system to be in place first. "There are many kinds of systems out there ... Integrating their data into ours is challenging."

"By bringing some standardization, we can rely better on all the data that comes in," commented Judge Hilton Fuller, a DeKalb County Superior Court judge and chairman of the Georgia Courts Automation Commission, which is funding the project. The database will also serve as a communications system, he added. "We'll be able to pass information between the courts, as well as the database. That's also an important part of this tool." PT

Plug a Friend into Electronics NOW®

and Save $41.89*

This Christmas give an electrifying gift ... plug a friend into Electronics Now and brighten the whole new year! Whether electronics is your friend's livelihood or hobby, your gift will illuminate the whole spectrum of electronics throughout the coming year and provide a monthly reminder of your friendship.

Electronics Now will keep your friend informed and up-to-date with new ideas and innovations in all areas of electronics technology ... computers, video, radio, stereo, solid-state devices, satellite TV, medical electronics, communications, robotics, and much, much more.

We'll provide great plans and printed circuit patterns for great electronic projects. In just the last few years, Electronics Now has presented amateur TV equipment, robots, computer peripherals, microcontroller programmers, test equipment, audio amplifiers, telephone projects, relay circuits, and much more.

PLUS ... equipment troubleshooting techniques ... circuit design ... reports on new technology and products ... equipment test reports ... in-depth coverage on computers, video, audio, vintage radio ... and lots more exciting features and articles.

*Basic sub rate — 1 yr/$24.99 2 yrs/$48.99

SAVE $41.89* ... OR EVEN $83.78* ... For each gift of Electronics Now you give this Christmas, you save a full $41.89* off the newsstand price. And as a gift donor, you're entitled to start or extend your own subscription at the same Special Holiday Gift Rate—you save an additional $41.89*!

No need to send money ... if you prefer, we'll hold the bill till January, 1999. But you must rush the attached Gift Certificate to us to allow time to process your order and send a handsome gift announcement card, signed with your name, in time for Christmas.

So do it now ... take just a moment to fill in the names of a friend or two and mail the Gift Certificate to us in its attached, postage-paid reply envelope. That's all it takes to plug your friends into a whole year of exciting projects and new ideas in Electronics Now!

BY SAM GOLDWASSER
SERVICE EDITOR

Specific Problems, Interesting Signals, and More

THIS MONTH, WE WILL CONCLUDE OUR SERIES ON CD PLAYERS AND CD-ROM DRIVES WITH SOME NOTES ON SOME COMMON PROBLEMS THAT OCCUR WITH A VARIETY OF PIONEER MODELS. THEN, WE'LL TAKE A LOOK AT THE EXCITING world of the CD player "eye pattern" and other interesting signals, and then wrap things up with some other "items of interest!"

Pioneer Problems

Note that we are not singling out Pioneer for any particular reason. These or similar problems also occur with units from other makers. It is just that we are familiar with the machines from this company. So, let's get started:

Pioneer PD/M series players/changers do not recognize discs:

There are a variety of Pioneer models that use basically the same or a very similar optical deck, and thus are subject to several problems that ARE likely to occur eventually on all these units. Where a Pioneer player or changer does not recognize discs, the most common causes are:

1. Partially shorted spindle motor due to "crud" on commutator. Cleaning might be possible. The disc might spin, but at insufficient speed. Try the unit's test mode toward latter (outer) part of disc as the required rotation rate is lower and/or check voltage to motor; if you are not familiar with the test mode, we'll go over it in a moment.
2. Cracks in flex cable to optical pick-up assembly. If that is the cause, replacement of flex cable will be required. That defect might also result in erratic operation while playing.
3. Collapsed rubber suspension grommets. There may be a scraping or clicking sound associated with that failure. For changers, gently lift up on the optical pickup assembly while the disc is attempting to spin to see if the disc is recognized and will play. To fix, you need to replace the deteriorated grommets.

Let's now discuss the Pioneer PD/M series test mode, which is extremely useful for narrowing down problems. Note that you might also find similar test modes on players from other companies, but details will likely differ.

- To enter the test mode, press the test button while turning power on and then hold it on for at least 1 second.
- Some models only have a set of contacts; on those, short between the contacts with a piece of wire or a paper clip.
- On players with a standby mode (not a hard on/off switch), plug the unit in while pressing the test button or shorting the contacts.

The test button or contacts are located on the main board (usually near the front right corner, and might be obscured by cables).

Once the test mode is engaged, the servos can be controlled from the front panel:

- STOP turns all servos off.
- TRACK FWD enables the focus servo (and loads disc 1 in changer).
- PLAY enables the spindle servo.
- PAUSE enables the tracking servo.
- Use manual search FWD or REV to move the optical pickup.

Note that, depending on model, the specific functions and behavior of the front panel buttons in test mode might vary slightly.

WARNING: Normal safety checks are disabled in the test mode. Thus, the laser might remain on as long as focus/tracking/spindle servos are engaged even if no disc is in place. Take care.

Power cycle (by unplugging if necessary) to return to normal mode.

Pioneer spindle motor problems:

When operating normally, here are the typical measurements for the PD/M series players: Spinup: >2.5 volts; time to lock (est.): 1-2 sec.; start of disc (500 rpm): 1.0 volt; and end of disc (200 rpm): 0.5 volts. Similar values apply to many other cheap permanent-magnet-type CD-player spindle motors.

When bad, the spindle servo drive tops out at around 0.6 V and 100 mA. The player is therefore unable to spin up to required 500 rpm to read disc directory.

While the exact cause of this problem is unclear, the theory is that a large voltage applied at startup followed by long periods of very low voltage (0.5-2 volts) operation allows conductive crud (carbon) to build up on the commutator, eventually reducing resistance to the point where the driver cannot apply enough voltage to achieve 500 rpm. The spindle-motor servo drive IC becomes quite warm when attempting to power a shorted motor. However, it does not appear to be harmed.

A short squirt of degreaser through the motor access holes and/or spinning the motor when disconnected from the player (using a 9- to 12-volt battery or power supply) will have an immediate dramatic effect, often returning operation to normal. However, just how long either of these "fixes" will last is another matter.

If the above fixes don't cure the problem, enter the test mode to play disc at outer track. If this is normal, then the spindle motor is probably bad as the rotation speed at the outer tracks is less (200 rpm) and a partially shorted motor may still run fast enough for this.

One last note before we leave the Pioneer players: The basic servo alignment procedure for Pioneer CD players is virtually identical to the general one presented last month.

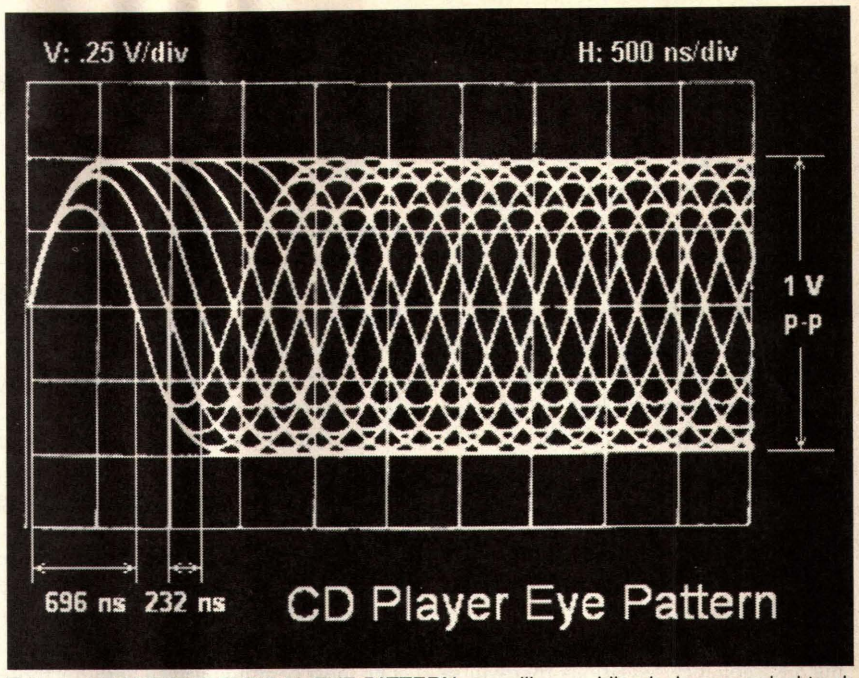


FIG. 1—HERE'S THE TYPICAL EYE PATTERN you will see while playing a musical track or reading data from a CD-ROM. If the pattern is well formed, you can be reasonably certain that the unit's optics are fine.

Interesting CD-Player Signals

Poking around inside a working CD player makes an excellent exercise for the student. Component CD players very often have clearly marked test points for RF, focus, tracking, and audio data. With care, (basic ESD precautions, careful probing, etc.) there is little risk of damaging anything as long as you are not tempted to try your hand at tweaking any of the internal adjustments.

If you have nothing better to do and you have your CD player open, try to locate the test points for data, fine tracking, and focus. They may be labeled something like TP.DTA (or TP.RF), TP.FO, TP.TR. TP.DTA or TP.RF is the data coming off of the disc having gone through only the photodiode segment combiner and preamp (probably). Using a 10:1 probe, set your oscilloscope for a horizontal sweep of around 0.5 μs/div. Try a vertical sensitivity of 0.2-volts per division to start and adjust for a full screen display. Use internal positive triggering. While playing a disc, you should see the classic "eye" pattern used in the communication world to characterize channel quality.

The Eye Pattern

The eye pattern results from the characteristics of the run-length-limited 8-14 modulation coding used on the CD, where there are no fewer than 3 and no more than 11 clock cycles per symbol. You should be able to make out the fact that the minimum distance between channel bits is 3 with the smallest distance between bit transitions of about 3×232ns (696ns). The readout clock is 1/(232 ns) or about 4.321 MHz.

A "good" eye pattern will be clean, symmetric, and stable with clear visibility in the cross-hatched areas. Its amplitude is typically in the 0.75- to 2-volt p-p range when measured at the RF test point. That waveform may be viewed using an oscilloscope of at least 5 MHz bandwidth. Some typical RF amplitude specifications are 1.3- to 1.4-volts p-p on Aiwa units, 1.2-volts p-p, on Sony full-size units, 0.85-volts p-p on Sony automotive and portable players.

Figure 1 shows the general form of the eye pattern present while playing a musical track or reading data from a CD-ROM using a typical unit. As the spindle servo adjusts motor speed, the instantaneous frequency could vary by 10 percent or more. Extensive buffering inside the player makes sure that a steady stream of data is sent to the D/A converter, and your ears!

Examining the eye pattern should be the first measurement that is performed to determine the condition of a CD player's optics and electronics. A good eye pattern eliminates most of the parts of the optical pickup from suspicion. Note that the eye pattern observed while the player is accessing the following areas of the disc may not be well formed as in Fig. 1:

- Disc directory (Table of Contents or TOC)
- Before the start of the first track (Track 1, time less than -0:01)
- Between tracks of distinct selections (where there is silence)
- After the end of the last track

(I await e-mail from anyone who can describe this waveform in detail!)

The reason why the pattern is not well formed is that there is no musical data at those locations on the disc (but probably a constant value like 0) and the TOC and/or time display is obtained from the Q bit. The Q bit is part of the Control and Display byte that is present once per frame (14 EFM coded bits out of 588 total bits per frame) as discussed earlier in this series. As a result, the funny looking eye pattern at those point has much more low frequency content and thus does not exhibit the nice cross hatched area that you see when the highly variable audio data is present.

Focus and Tracking Drive or Error Signals

TP.FO or TP.FE is the focus voice-coil error signal. Monitoring that signal with a disc in good condition will show what looks like noise—the more or less random fluctuations in the actuator current that is necessary to maintain proper focus within ± 0.5 μm of the disc surface. On a warped disc you will see the DC level of this signal varying at the disc rotation rate. On a damaged disc, you

will see higher-frequency variations in the level depending on what kind of defects are present. Gently tapping the optical deck should evoke a visible effect on this signal as the servos correct for your mischief.

TP.TR or TP.TE is the fine-tracking voice-coil error signal. As with TP.FE, it will show a noise waveform with a good disc. On a disc with runout, you will see a periodic level variation at the spindle rotation frequency. Note how the DC value of that signal gradually changes as the voice-coil actuator maintains lock on the track while the track spirals outward.

Eventually, that error becomes great enough to trigger the coarse-tracking motor to jog the pickup a fraction of a mm and re-center it on the track, at which point the signal you are watching will suddenly shift its DC level.

On a disc with scratches, there will be higher frequency deviations that will be readily visible on a scope trace. Gently tap the optical deck from various points and observe the effects on this signal.

For both focus and tracking, you can actually hear the voice-coil actuators as they compensate for minute defects or just the normal data pattern. That is the "gritty" sound one hears from the CD audio or CD-ROM transport when it is operating correctly, and is an indication that the laser and focus (at least) are most likely functioning properly. If you listen carefully, you can actually hear various defects by the effect they have on that gritty sound, but there will be no corresponding effect in the audio outputs as there would be with an LP.

Focus, Tracking, and Error-Correction Performance

If you have a test CD (or you could also use a regular CD for this), put your scope on one of audio outputs. Create some "defects" by placing some thin pieces of tape or by marking with a (water-soluble) felt-tipped pen radially on the bottom surface of the disc. Play some tracks that have constant pure tones or silence. For widths less than the error correcting capability of your CD's LSI chipset, there should be no detectable signal degradation.

As an experiment, you might want to see what happens as you increase the width of your "defects." Another thing to try is to put your finger on the spindle or even gently touch the disc as it is rotating. Note that unless you really press hard, the disc will continue to play normally without any change in pitch. This is due to the servo control and extensive buffering of the data—unlike an LP turntable where the instantaneous speed is what determines pitch. Other experiments are left as exercises for the student.

Laser-Diode Fundamentals

Note: What follows here is a summary. For additional information on using laser diodes, see the document entitled: "Sam's Laser FAQ: Safety, Info, Links, Parts, Types, Drive, Construction" at my Web site (www.repairfaq.org).

Typical CD laser optics put out about 0.1 to 1 mW at the objective lens, though the diodes themselves might be capable of up to 4 or 5 mW depending on their type. The laser diodes for CD players are infrared, with a wavelength of usually around 780 nm. Visible laser diodes are also readily available from many sources. The most common wavelength for those is 670 nm—which is deep red—but 630-nm diodes are also available; the later are red/orange and appear much brighter (they are also more expensive at the present time). Inexpensive (relatively) laser pointers use visible laser diodes with power outputs up to about 5 mW. That is enough power to risk permanent retinal damage if you look into the beam, especially when it is well collimated as is required for a pointer. Needless to say, you should never look directly into any laser beam

Typical currents for laser diodes are in the 30 to 100 mA range at 1.7 to 2.5 volts. However, the power curve is extremely non-linear. There is a lasing threshold below which there will be no output. For a diode rated at a threshold of 80 mA, the maximum operating current may be as low as 85 mA. That is one reason why all actual applications of laser diodes include optical sensing (there is a built-in photodiode in the same case as the laser emitter) to regulate beam power. You can easily destroy a laser diode by exceeding the safe current even for an instant. To protect the life of the laser diode, it is critical that you do not exceed the safe current limit—even for a microsecond!—under any circumstances.

Laser diodes are also extremely sensitive to electrostatic discharge, so use appropriate precautions. Also, do not try to test them with a VOM; the test currents they put out on the low-resistance ranges could exceed the diode's safe current rating.

While only a few hundred mW at most are dissipated by a laser diode, a good heat sink is also important for the device's long life and stability. That's one of the reasons why the optical pickup is usually a metal casting. Remember that the active diode chip is only about 0.1 mm on a side. However, some optical blocks are now made of plastic, so this might not be as important as in the past.

It is possible to drive laser diodes with a DC supply and resistor, but unless you know the precise value needed, you can easily exceed the ratings. One approach that works for testing is to use a 0- to 10-VDC supply (preferably a linear supply—a switching supply might put out laser-diode destroying pulses) with, say, a 100-ohm resistor in series with the diode. Slowly bring the current up until you get a beam (use an IR detector to test for the presence of the beam). If you get the polarity backwards or are actually measuring across the internal photodiode, the voltage across the diode will go above 3 volts or will be less than 1 V. If you see that, turn power off and reverse the leads. **Note:** Some laser diodes will be destroyed by reverse voltages greater than 3 V—the device's spec sheet will list the reverse voltage rating; however, the ones I have tried out of CD players were fine to at least 5 V in the reverse direction.

Without a laser power meter, however, you will have no way of knowing when the limit on safe beam power (safe for the laser diode, that is) is reached. If you have the data sheet for your laser diode, then the best you can do is limit the current to specified maximum rating. Also, there is usually a weakly visible emission which appears red (for IR laser diodes) when the device is powered. Do not be fooled into thinking that the laser diode is weak as a result of that dim red light. The main beam is IR and invisible—and up to 10,000 times more intense than it appears.

The beam from the raw laser diode is emitted in a broad wedge, typically 10 × 30 degrees. A convex lens is needed to collimate the beam (make it parallel). For optimal results, the lens needs to be anamorphic—it has unequal horizontal and vertical focal lengths—to correct the astigmatism of the beam. The mass produced optical pickups used in CD players have that characteristic, as well as other sophisticated optics.

For an actual application, you should use the optical feedback to regulate beam power. That usually takes the form of a

simple current-controlled power supply with extensive capacitive filtering and a regulated reference. It is possible to modulate the beam power by tapping into the feedback circuits—as long as you take steps to ensure that the maximum current specification will never be exceeded. Laser diodes do not behave like LEDs and cannot be pulsed for higher peak power—they turn into DEDs—Dark Emitting Diodes. Single chips for driving laser diodes in both CW and modulated modes are available from a number of manufacturers.

Laser Diode Life

For all intents and purposes, laser diodes in properly designed circuits do not degrade significantly during use or when powered on or off. However, as we saw above, it doesn't take much to blow them. I have seen CD players go more than 10,000 hours with no noticeable change in performance. That doesn't necessarily mean that the laser diode itself isn't gradually degrading in some way—just that the automatic power control is still able to compensate fully for any changes.

So, then, why do some laser diodes fail prematurely? In most cases they were either defective to begin with, their driver circuitry was inadequate, or they experienced some "event" resulting in momentary (perhaps only a few nanoseconds) overcurrent.

As noted elsewhere, a weak laser diode is well down on the list of likely causes for CD player problems.

Of course, in the grand scheme of things, even LEDs gradually lose brightness with use.

Going Further

If the solutions to your problems have not been covered in this series of Service Clinic articles (or the much more extensive FAQs at my Web site), you still have some options other than surrendering your CD player to the local service center or the dumpster.

When tackling electronic faults, a service manual with schematics will prove essential. Many manufacturers will happily supply this for a modest cost—typically $10 to $50. However, some manufacturers are not providing schematics in their manuals; only mechanical and alignment information. Confirm that a schematic (not just a block diagram) is included if you need one before purchasing the manual.

If you don't have the schematic, all is not necessarily lost. Test point locations, important signals, and power-supply voltages are often clearly labeled on the electronics board. In this case, quite a bit of troubleshooting can be done without the schematic. There is a good chance that the problem can be isolated to a particular subsystem by just following the signals using this information.

There are also a variety of books dealing with all aspects of CD player repair. While not as common as books on VCR repair, there are more of these than you might think. Your local public library may have some in the electronics section. Technical bookstores, electronics distributors, and the mail-order parts sources listed elsewhere in this article often carry a variety of these texts.

Troubleshooting and Repairing Compact Disc Players, Homer L. Davidson, TAB Books, A Division of McGraw Hill, Inc., Blue Ridge Summit, PA 17294, USA, 1989, ISBN 0-8306-9107-3 (hardcover), ISBN 0-8306-3107-0 (paperback). That text includes several complete CD-player schematic diagrams (which are quite interesting in their own right). I believe there is now a third edition of this book.

Compact Disc Troubleshooting and Repair, Neil Heller and Thomas Bentz, Howard W. Sams & Company, A Division of Macmillan, Inc., 4300 West 62nd Street Indianapolis, IN 46268, USA, 1988, ISBN 0-672-22521-2.

The Compact Disc Book - A Complete Guide to the Digital Sound of the Future, Bryan Brewer and Edd Key, Harcourt Brace Jovanovich, Publishers, Orlando, FL 32887, 1987, ISBN 0-15-620050-3 (paperback). Includes a variety of high level information but no details.

The Complete Guide to Digital Audio Tape Recorders including Troubleshooting Tips, Erik S. Schetina P.T.R., Prentice Hall, Englewood Cliffs, NJ, 07632, ISBN 0-13-213448-9. Mostly directed to digital-audio-tape recording, but also includes some information on digital sampling and CIRC coding.

DAT - The Complete Guide to Digital Audio Tape, Delton T. Horn, TAB Books, Inc., Blue Ridge Summit, PA 17294-0214, 1991, ISBN 0-8306-7670-8 (hardcover), ISBN 0-8306-3670-6 (paperback. Includes a chapter on the compact disc.

All Thumbs Guide to Compact Disc Players, Gene B. Williams, TAB Books, Inc., Blue Ridge Summit, PA 17294-0214, 1993, ISBN 0-8306-4179-3 (paperback). This one is very basic but does cover the most common problems and has illustrated instructions for hookup, cleaning the lens, cleaning and lubricating the mechanism, simple electronic problems, etc.

On the Internet, Tandy (Radio Shack) has a nice web resource and fax-back service. This is mostly for their equipment but some of it applies to other brands and there are diagrams that might be useful for other manufacturers' VCRs, TVs, CD players, camcorders, remote controls, and other devices (since Tandy does not manufacture its own equipment your model may actually be covered under one of their house brands such as Realistic or Optimus—it might just take a little searching to find it). The address is http://support.tandy.com.

Some Notes on Parts

The type of belts used in CD players for drawer loading and sometimes elsewhere is nearly always a type with a square cross section. Obtaining an exact replacement belt may be difficult and not really necessary.

Measure the old belt and select one that is as close as possible from a parts supplier like MCM Electronics. What is important here is that it be of equal or slightly greater thickness and that it has an inside circumference (this is how they are measured) so that it will be tight but not so tight as to slow the motor or cause damage to the bearings. That usually means a circumference that is about 5 to 10 percent less than the old (stretched) belt.

The question often arises: If I cannot obtain an exact replacement or if I have a CD, VCR, or other equipment carcass gathering dust, can I substitute a part that is not a precise match? Sometimes, you might want to do this simply to confirm a diagnosis and avoid the risk of ordering an expensive replacement and/or having to wait until it arrives.

Anyway, for safety-related items, the answer is generally no; an exact replacement part is needed to maintain the specifications within acceptable limits with respect to line isolation, X-ray protection, and to minimize fire hazards. The good news is that there are not that many safety-related components in CD players.

Still, although only a few manufacturers produce most of the components in CD players and CD-ROM drives, don't expect a lot of readily interchangeable parts other than the common electronic ones listed below. In their never-ending

search for cost reductions and technology improvements, manufacturers are constantly tweaking their designs. More and more circuitry is finding its way into custom VLSI chips. Fortunately, those do not fail too often.

The only parts that are fairly standardized aside from the electronic components are motors. Often, if the motor is physically interchangeable, then it will work as a replacement. Electronic components and entire circuit boards (if identical models and production run) can often be substituted without difficulty, though servo alignment will probably be needed due to slight unavoidable differences between apparently identical pickups or electronic components.

For common components, whether a not-quite-identical substitute will work reliably or at all depends on many factors. Except for the optical pickup, non-custom components in CD players are fairly standard.

Here are some guidelines:

Fuses: Make sure that any substitute has the exact same current rating and at least equal voltage rating. I have often soldered a normal 3AG size fuse onto a smaller blown 20 mm long fuse as a substitute.

Resistors, capacitors, inductors, diodes, switches, potentiometers, LEDs, and other common parts: Except for those specifically marked as safety-critical, substitution is fine as long as the replacement part fits and specifications are the same. It is of course best to use the same part types as originally called for—for example, don't substitute a carbon resistor for a metal-film one. But for testing, even that is not a hard and fast rule, and a carbon resistor should work just fine.

Rectifiers: Replacements should have an equal or better PRV and I_{MAX} specifications. For power-supply rectifiers, 1N400x types can usually be used.

Transistors: Substitutes will generally work as long as their specifications meet or exceed those of the original. For testing, it is usually fine to use types that do not quite meet all of the specs as long as the BV_{CEO} and I_C specifications are not exceeded. However, performance may not be quite as good. For power types, make sure to use a heatsink.

Motors: Small PM motors may be substituted if they fit physically and their winding resistance are reasonably similar (say, within 25 percent of each other). Brushless DC spindle motors are not usually interchangeable.

Sensors: Many sensors used in CD players are sufficiently similar to permit substitution.

Power Transformers: In some cases, these may be sufficiently similar that a substitute will work. However, make sure you test for compatible output voltages to avoid damage to the regulator(s) and rest of the circuitry.

Belts: A close match should be good enough at least to confirm a problem or to use until a replacements arrives.

Mechanical Parts: Screws, flat and split washers, C- and E-clips, springs, etc. can often be salvaged from another unit.

Optical Pickups: This is discussed in the next section.

The following are usually custom parts and substitution of something from your junk box is unlikely to be successful even for testing: Microcontrollers, other custom programmed chips, display modules; and entire optical pickups, optical decks, or power supplies unless identical.

Repairing an Optical Pickup

Once you have located a problem in the optical pickup, what should you do? The quick answer is: probably nothing. In the end any such attempts may simply prove too time consuming and frustrating.

The only repair below the pickup level that I would consider as having a reasonable—though still not great—chance of success would be to swap the lens assembly including focus and tracking coils between identical pickups. The optical alignment is not supercritical at this point (however, servo alignment might be needed after this exchange).

Parts Sources

For general electronic components like resistors and capacitors, most electronics distributors will have a sufficient variety at reasonable cost. Even Radio-Shack can be considered in a pinch.

However, for the kinds of components used in consumer-electronics equipment—such as Japanese semiconductors, flyback transformers, or even degauss Posistors—there are a few sources you should be familiar with.

MCM Electronics (VCR parts, Japanese semiconductors, tools, test equipment, audio, and consumer-electronics replacement parts such as microwave-oven components and electric-range elements, etc.) Tel: 800-543-4330; Fax: 513-434-6959; Web: www.mcmelectronics.com/

Dalbani (excellent Japanese semiconductor source, VCR parts, other consumer electronics, Xenon flash tubes, car stereo, CATV) Tel: 800-325-2264, International Tel: 1-305-716-0947; Fax: 305-594-6588, International Fax: 1-305-716-9719; Web: http://www.dalbani.com/

Premium Parts (very complete stock of VCR parts, some tools, adapter cables, other replacement parts.) Tel: 800-558-9572; Fax: 800-887-2727.

Computer Component Source (mostly computer monitor replacement parts, but also some electronic components including semiconductors.) Tel: 800-356-1227, International Tel: 1-516-496-8780; Fax: 800-926-2062, International Fax: 1-516-496-8784.

Closing Comments

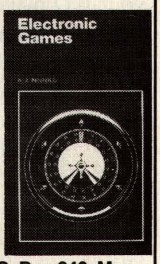
Well, that's it! If you have been following this series on CD players and CD-ROM drives, you now have all the information you should need to understand at least the basics of how this technology works and to be able to remedy the majority of common problems with CD (and other optical disc) equipment.

In case you haven't noticed, this and the other material in the "Service Clinic" column are derived from the much more extensive and detailed documents—the FAQs—at my Web site: www.repairfaq.org. So, if what you were looking for hasn't been addressed, please check there!

Also, please e-mail me with your feedback; the address, as always is sam@stdavids.picker.com. I would like to know how you liked this series; whether it was too long, too short, or just right; what you would like to see covered in the future; and anything else relevant to making "Service Clinic" a monthly column you just HAVE to read!

See you next time. EN

ELECTRONIC GAMES



BP69—A number of interesting electronic game projects using IC's are presented. Includes 19 different projects ranging from a simple coin flipper, to a competitive reaction game, to electronic roulette, a combination lock game, a game timer and more. To order BP69 send **$8.00 (includes s&h)** in the US and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.** US funds only. Use US bank check or International Money Order. Allow 6-8 weeks for delivery. MA07

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Mind Your Ones and Sevens

It has come to our attention that there was an error in the "No Parts PIC Programmer" article in the September 1998 issue of **Electronics Now**. In the description on the operation of the hardware portion of the project in the second column on page 36, the original text read "When pin 11 of the printer port is low, D1 conducts." The pin number should have read 17 instead of 11. Since the cathode of D1 is connected to pin 17, grounding that pin would be the only way for D1 to become forward biased. Additionally, pin 11 on the printer port is for input only—it is not able to output an active voltage level.—*Editor*

More Who Are You

I'm a 53-year-old ham who enjoys your magazine **Electronics Now**. I like having some of everything in each issue and really am quite happy with it just the way it is. Keep up the good work, and I'll keep reading.

EARL KOLANDA, WA7Q1U
via e-mail

I'm an electrical engineer and co-owner of a small electronics development company, Sensor Technology Engineering, Inc. I have been reading your magazine for many years, and I have always enjoyed it.

Educationally, I have a bachelor's degree in physics and a masters degree in electrical engineering. Prior to forming my own company, I worked for one of the national laboratories. Most of my day is spent designing circuits, and electronics is my business and my livelihood.

But it's my hobby also, and one of my life's passions. As a kid, I pored over issues of **Popular Electronics** and **Radio-Electronics**. Gernsback's magazines kindled the fire of interest in electronics that led me to where I am today. I suspect one of the reasons that the U.S. has led in the development of electronics in this century has been that there are lots of guys like me out there.

The basic formula of your magazine works as well today as it did 40 years ago. I find project articles are always interesting, even though I rarely build any of them. It's fun for me just to figure out if they'll work or not. What's new articles are also good, provided they have some technical content to them. Don Lancaster's column is worth the price of the magazine all by itself.

I love the clever and elegant construction articles best. The beverage-can radon monitor comes to mind as an all-time great. The complexity of the project doesn't mean much to me, provided I can sit down and read about it and reach an understanding of how it works. I don't like construction articles where the author holds back necessary details, such as software, or uses gate arrays since it is impossible to determine what they are doing by simply reading the article. And despite what many authors suggest, most of the construction article projects can be built without their PC boards.

Some of the computer articles are interesting, but I wouldn't push aside the basic electronics in the hope that computer articles will attract more readers. There are lots of magazines about computers and very few electronic hobbyist magazines. Trying to be everything to everybody is always a losing strategy—you end up being nothing much to anyone.

It is my opinion that you should challenge your readers and push their knowledge level a bit. I think it's a mistake to underestimate the capabilities of hobbyists. I've seen some remarkable things accomplished for the sheer objective of having fun!

I appreciate your seeking the opinions of your readers concerning the contents of your magazine. However, don't doubt yourself too much—your magazine is important and has a far-reaching influence.

KEN VADNAIS
via e-mail

EN

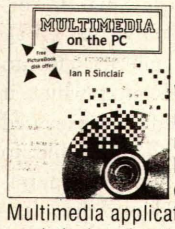
Write To:
Letters,
Electronics Now Magazine,
500 Bi-County Blvd.,
Farmingdale, NY 11735

Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

BE A TEACHER. BE A HERO.

Call 1-800-45-TEACH.

Ad Council — A Public Service of This Publication



MULTIMEDIA on the PC!

What is Multimedia? What can it do for you? It can do lots of nice things! This 184-page book helps you create your own multimedia presentation. Multimedia applications by people like you can revolutionize educational and business applications as well as bring more FUN, FUN, FUN into your leisure computer activities.

Mail coupon to:

Electronics Technology Today, Inc.
P.O. Box 240
Massapequa Park, NY 11762-0240

Please send me my copy of *Multimedia on the PC* (PCP120). I enclose a check or money order for **$18.95** to cover the book's cost and shipping-and-handling expenses. NY state resident must add local sales tax.

Name _____

Address _____

City _____ State _____ Zip _____

All orders must be paid in U.S. funds only. Sorry, no orders accepted outside of USA and Canada. Please allow 6-8 weeks for delivery. MA02

BY JEFF HOLTZMAN
COMPUTER EDITOR

Comparative Anatomy

LAST MONTH, WE BEGAN A PROJECT TO IMPLEMENT A C COMPILER FOR THE AVR LINE OF MICROCONTROLLERS. WE COULD START FROM SCRATCH, BUT THERE'S AN EASIER WAY: THE SMALL C COMPILER FIRST PUBLISHED IN *DR. DOBBS JOURNAL* almost 20 years ago. That compiler was created by James E. Hendrix; full source is available. The very first version of Small C was created on and for a Z80 microprocessor running CP/M. The final version (2.2) was created on and for an Intel CPU running DOS. Many ports of Small C exist (*e.g.*, to 8051, 6502, and more).

To implement a compiler for a given CPU or MCU, you must have a detailed understanding of the architecture of the target device. In addition, Small C initially generates code for a virtual CPU, and then translates that generic code into 8086 assembly language, after which it can be assembled, linked, and executed on the target system. To be able to change Small C's code-generation module, you must understand both the virtual CPU and the target, in this case, the AVR microcontroller family.

Thus, to initiate this project, we're going to hold a course in comparative anatomy. But you don't have to worry about the smell of formaldehyde or cutting up organic tissues. Our subject is silicon, and we'll do it on paper.

The Virtual Architecture

Internally, after parsing the input text, Small C generates pseudo-codes (p-codes), which it then translates into x86 assembly language. An external assembler translates the assembly language text into a relocatable machine-code object file. Then an external linker combines the object file(s) with the C run-time library to produce an executable file. Figure 1 illustrates the process.

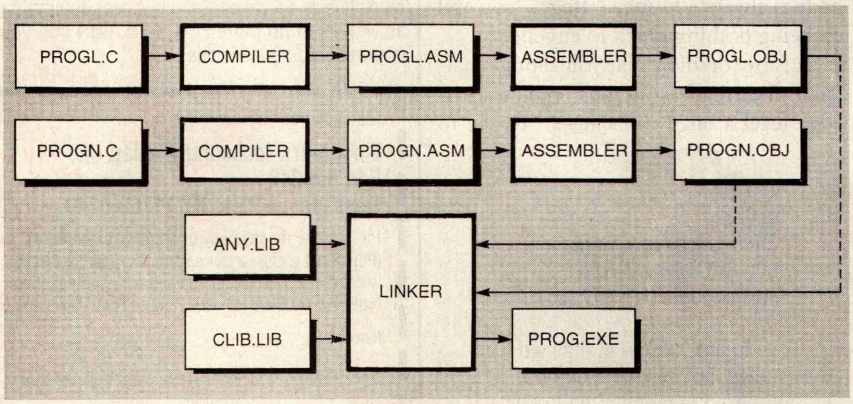


FIG. 1—THE PROGRAM CREATION PROCESS in Small C: One or more C program files is compiled, assembled, and linked with the Small C library (and optionally other libraries), and finally linked to produce an executable.

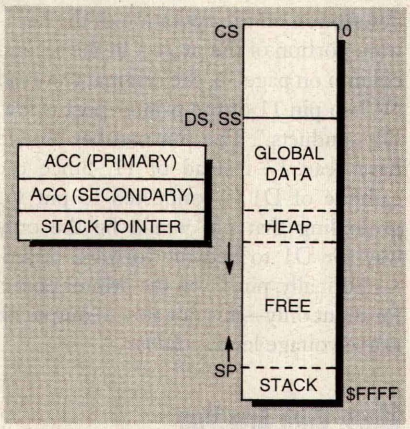


FIG. 2—SMALL C's COMPILER MODEL as implemented on an 8086 CPU. The Code Segment is fixed in size and is as large as 64K. The Data and Stack segments are equal, and also as large as 64K. The Heap grows up and the Stack grows down; woe should they ever meet!

As mentioned last time, Small C includes its own assembler, but no linker. DOS used to come with a linker, and most old 16-bit development tools did as well, but that's no longer true. I'll post a copy of a very old version of Borland/Inprise's TLINK.EXE, which is adequate for our purposes, on the Ingeneering Web site (www.ingeninc.com).

Unfortunately, in Small C the dividing line between the parsing and code-generating phases is not as clean as the diagram makes it seem. Some of the earlier phases actually emit some assembly language, and it's hard coded to the Intel CPU family. That doesn't affect us now, but it will later, when we actually start generating code. At that time we'll borrow a trick from Andy Yuen, who implemented a multitasking module for Small C. (Andy's trick involves adding additional p-codes, thereby removing the architectural dependency.)

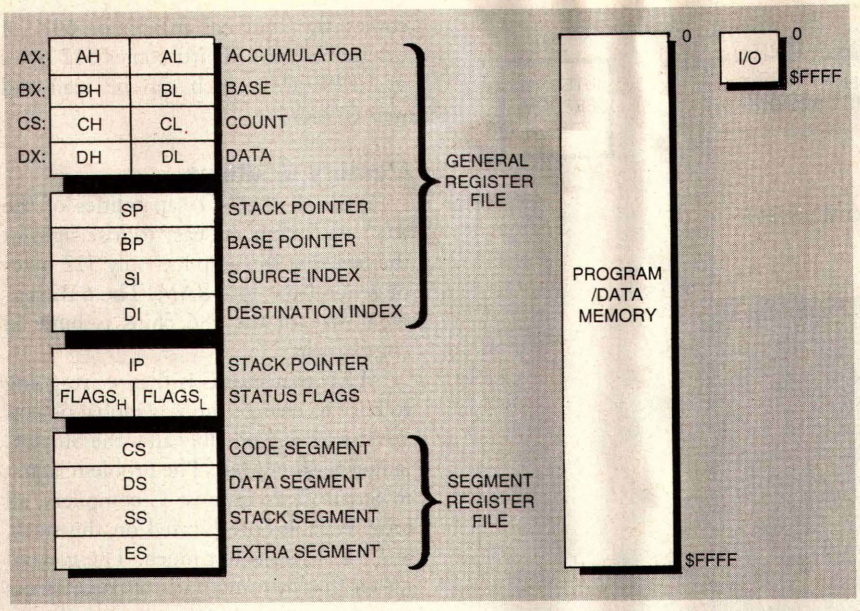


FIG. 3—THE 8086 REGISTER, memory, and I/O model: It might not look like much, but it kicked off the PC revolution.

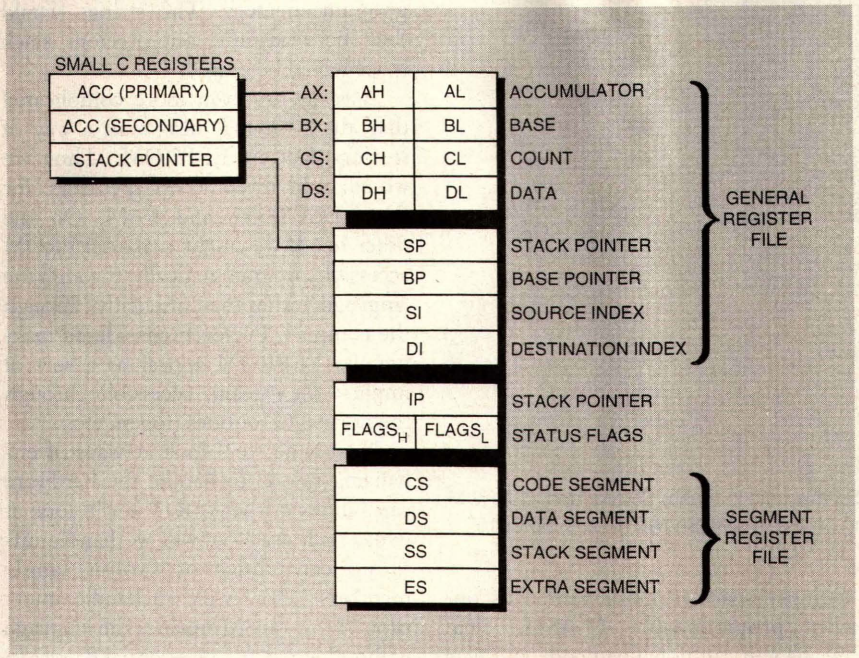


FIG. 4—SMALL C's VIRTUAL CPU maps to an 8086 as shown here.

The processor for which the p-codes are generated is the so-called virtual CPU mentioned above; its architecture appears in Fig. 2. The CPU has two accumulators (primary and secondary), a stack pointer, and a unified program and data memory store. That memory is used for program code, the stack, and the heap. The heap is where dynamically allocated memory exists. In a running program, the heap and the stack share some big chunk of memory; the heap grows upward, and the stack grows downward. A program may crash or data may be corrupted if they ever cross.

The x86 Architecture

The 8086 architecture is more complicated. As shown in Fig. 3, there are four general-purpose registers (A, B, C, and D); four memory index pointers (SP, BP, SI, and DI); the program counter; a set of flags; and four segment registers (CS, DS, SS, ES). Each general-purpose register can be addressed as a 16-bit whole (*e.g.*, AX), or in 8-bit halves, high and low (*e.g.*, AH and AL). There is also a separate 64K space for I/O, and a 20-bit (1 MB) program memory.

The segment registers require special explanation. By itself, a 16-bit register can address a maximum of 65536 bytes, or 64K of memory. To surmount that limit, all x86 CPUs allow a 20-bit address to be formed by taking the contents of a segment register, multiplying by 16, and then adding the contents of a base register. Doing so gives an effective 1-megabyte address space, even though it makes life difficult for programmers. Just about any book on 80x86 assembly language programming can spell out the details, but for our purposes, they don't matter. Small C essentially ignores segmentation, effectively limiting Small C programs to 64K of code and 64K of data/stack. Today that may not seem like much, but remember, both Small C and Small Assembler are written in Small C, proving that useful does not necessarily have to be big.

As discussed above, the Small C virtual CPU has three registers; those are mapped to x86 registers as shown in Fig. 4. The remaining x86 registers can be used by the code-generating system of Small C any way it sees fit.

The AVR Architecture

The AVR is a microcontroller, which means that in some ways it is more complex, and in others, less so, than a general-purpose microprocessor like an x86. Various members of the AVR family have different I/O functions, including serial and parallel I/O, pulse-width modulation, A/D conversion, and so on. We're going to discuss a moderately high-end device, the 8515. The low-end devices are memory-poor, and higher-end devices are still expensive and hard to obtain. The 8515 provides a pretty good balance; for detailed information, request a data book from Atmel (2325 Orchard Parkway, San Jose, CA 95131), or see the company's Web site (www.atmel.com).

The 8515 has the following built-in capabilities: 4K × 16 program (flash) memory, 512 bytes of EEPROM, 512 bytes of static RAM, 32 8-bit general purpose registers, four 8-bit ports, a serial UART, a serial programming interface, an 8-bit counter, a 16-bit counter, two PWM outputs, external and internal interrupts, a watchdog timer, and an analog comparator. The 8515 comes in 40-pin DIP and 44-pin PLCC packages, can run at 2.7± 6.0 volts DC, has fully static operation up the rated clock speed, single-cycle execution of most instructions, and lock bits for software security. Several functions are multiplexed to single pins, so you can't have all capabilities active simultaneously.

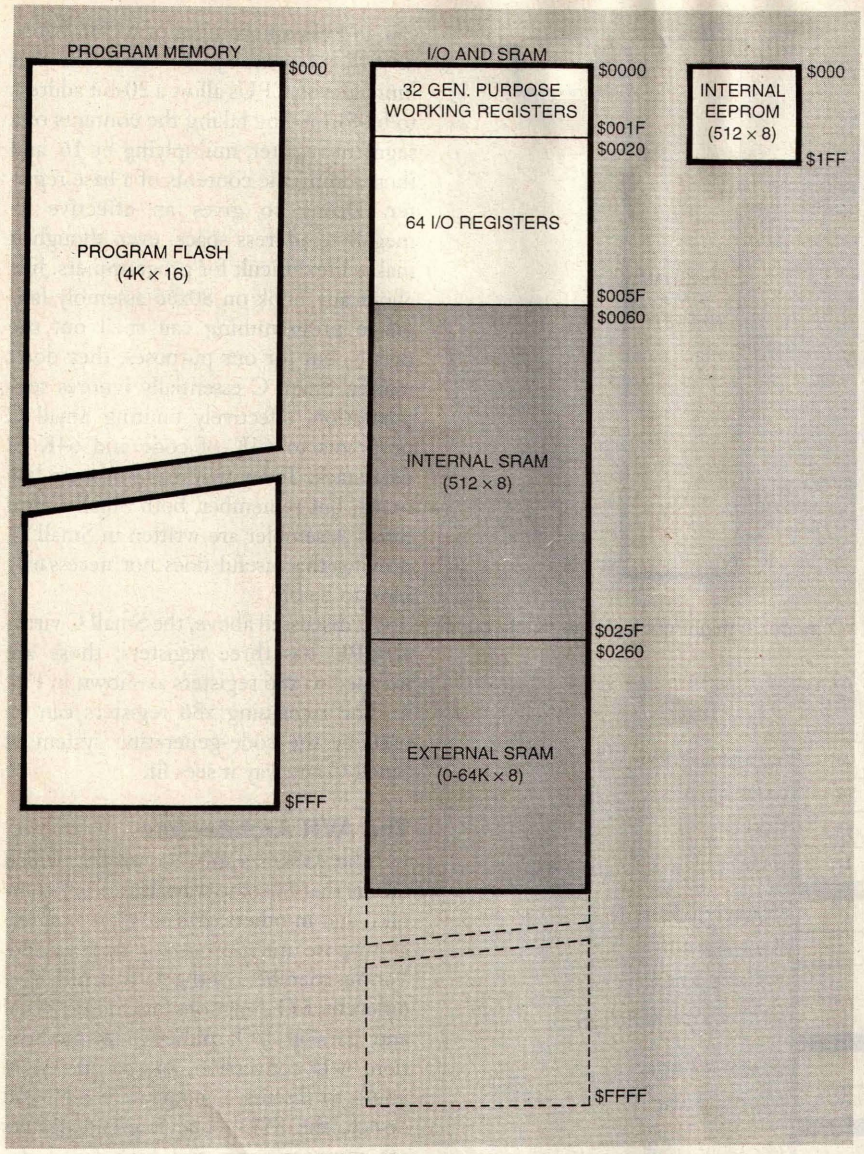


FIG. 5—ATMEL's AVR MICROCONTROLLERS have built-in Flash, SRAM, and EEPROM, as well as extensive I/O capabilities, depending on the model. Shown here is the 8515.

For example, you can use two of the 8-bit ports to implement up to 64K of external static RAM.

The 8515's memory architecture appears in Fig. 5. Note that are three separate memory spaces. The program memory space is implemented as on-chip programmable FLASH. That means you can download code and data to the program memory space, and it will remain there indefinitely. However, the program memory space is essentially ROM; you cannot write to it within a local program.

The data memory space has several unusual features. Working from top to bottom, note that the CPU's 32 general-purpose registers are addressable here. You can also address them directly (*e.g.*, R1, R2, ... R32). Following the general-purpose registers are the I/O registers. Those allow controlled access to all the I/O capabilities of the MCU, including ports, control registers, setup registers, and so on. Next comes 512 bytes worth of internal static RAM. Following that comes the optional maximum 64K of external SRAM. Third comes 512 bytes of EEPROM, which can be read and written locally.

Memory Madness

With all the I/O capabilities of the 8515 AVR chip, it's easy to lose sight of the fact that the chip has only 512 bytes of general-purpose RAM. The 64K segment size of the x86 chips is huge in comparison.

What that means is that we're going to have to change the way global objects are stored, and possibly alter the Small C language somewhat. The problem is that in Small C, as in most C compilers, all local variables are located on the stack, and 512 bytes is not much. The general idea is that by using static or const access specifiers, we could force the compiler to store items such as long text strings in program memory. The strings would then be read-only, but precious stack space would be spared.

Actually, it's even more complicated than that. We may also want a way of storing data in EEPROM. Thus we would need three access specifiers: for flash, EEPROM, and RAM. On the other hand, we might make EEPROM accessible programmatically, through the language, rather than implicitly, through the compiler. I've even considered making the EEPROM appear as a sort of implicit file stream, accessible through the normal C routines (fopen, etc.).

Next time we'll look at ways of enhancing raw C to handle the hardware capabilities of the AVR. We will look at issues such as: How will we handle differing capabilities of various family members? How will we handle interrupts? How can we enhance the language without destroying its essential flavor? In the meantime, stay in touch via e-mail at jeff@ingeninc.com. EN

SMALL C RESOURCES

Dr. Dobbs Journal sells a CD-ROM that contains the complete text of James Hendrix' excellent, out-of-print book on Small C, as well as the complete source to Small C 2.2, several ports, and more than a dozen additional articles of interest. See www.ddj.com, or call 800-822-1162.

You can also visit the Tech Corner of the Ingeneering Web site (www.ingeninc.com), where I'll post the Small C source and executable, a linker, and any code generated as part of this project.

9 out of 10 mice prefer the Consumer Information Catalog online. Catch it at **www.pueblo.gsa.gov.**

U.S. General Services Administration

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Digital Multimeters

DESIGNED FOR ELECTRONIC and electrical technicians and for electricians, the 80 Series III digital multimeters (DMMs) from Fluke provide high-performance measurement accuracy. Durable, rugged, and highly portable, these units are true rms, analog/digital meters. They withstand power surges up to 8 kV and meet IEC 1010 CAT III 1000-volt safety standards.

The 80 Series III DMMs feature 11 functions for electronic and industrial applications, including high-performance DC/AC voltage and current measurement, frequency, duty cycle, resistance, conductance, continuity, diode test, and capacitance measurement. These meters offer improved resistance to EMI noise, 250 µS peak min/max, and .05% basic DC accuracy.

Included in this series are the Model 83 III, Model 85 III, Model 87 III, and Model 87/E III. The last-cited DMM is specially configured for electricians and comes with extra-long silicone-insulated test leads, customized test probes, and an SC20 industrial test clip.

All models feature a recording mode that captures the maximum, minimum, and average readings, while monitoring a signal. The meter emits a beep while recording to indicate that a new reading has been sensed and stored. Users can select response times from 100 ms to 1 second on all models. In addition, the 87 and 87/E have a 250 µs response setting for capturing fast transients, which can be used to isolate the peak of an AC signal.

Touch Hold and Relative modes are provided on all models. Touch Hold captures the measurement, beeps, and locks it on the digital display for later viewing. In this mode, readings are automatically updated with each new measurement. Relative mode remembers a reading and displays the difference between it and subsequent readings.

The 80 Series III DMMs are easy to read with an LED backlight that provides viewing under virtually any ambient conditions and an LCD with large digits and an improved viewing angle. A separate on/off control operates the backlight. Models 87 and 87/E have a 4-$^1/_2$ digit mode.

The battery access door enables the user to change batteries without breaking the calibration seal. A holster protects the meter, which measures approximately 7.3 by 3.4 by 1.2, when it is used in harsh operating conditions. List prices range from $279 for the 83 III to $369 for the 87/E III.

CIRCLE 20 ON FREE INFORMATION CARD

FLUKE CORPORATION
P.O. Box 9090
Everett, WA 98206-9090
Tel: 800-44-FLUKE or 425-356-5500
Fax: 800-FLUKE-FAX or 425-356-5116
e-mail: fluke@info@tc.fluke.com
Web: www.fluke.com

Portable CD-ROM Drive

MEANT FOR THE POWER USER who wants performance and portability, the CDPS-PX24 is a high-performance 24-speed SCSI CD-ROM drive. The durable, compact and lightweight CDPS-PX24 has a transfer rate of 3600 kbps and an access time of 90 ms. The included 16-bit SCSI-2 Interface Type II PC Card easily connects the CDPS-PX24 to any notebook PC, and it can be used with palmtops as well.

The drive supports CD-DA (audio), CD-ROM XA (video), enhanced CD, photo CD, and 8 cm CD. With headphone and lineout speaker jacks, it plays conventional CDs as well as CD-ROM. It is compatible with Windows 95, Windows 3.1, or DOS.

CIRCLE 21 ON FREE INFORMATION CARD

External controls and the LCD readout make the CDPS-PX24 easy to use. The drive weighs 370 grams and measures 5.2 by 8 by 1.1 inches. It operates from either six "AA" batteries or from AC power.

In addition to the PC card, the drive is bundled with interface cable, supporting software, 13.0-VAC adapter, and operating manual. It retails for $299.

I-O DATA DEVICE, INC.
2005 Hamilton Avenue, Suite 220
San Jose, CA 95125
Tel: 408-377-7062
Fax: 408-377-7085
e-mail: info@iodata.com

Adjustable Power Supply

THE HEAVY-DUTY MFJ-4035MV 35/30 amp adjustable regulated DC power supply features 35 amps surge and 30 amps continuous power. Voltage is front-panel adjustable from 1 to 14 VDC. Detent is set at 13.8 VDC. The front panel of the MFJ-4035MV has lighted meters—a volt-meter and an amp-meter that monitor the load continuously—an easy-to-reach on/off switch, and a fuse holder for convenient fuse replacement.

There are three different output terminals: a five-way binding post for HF/VHF radio, two pairs of quick connects for low-current accessories, and a cigarette lighter socket for mobile accessories.

CIRCLE 22 ON FREE INFORMATION CARD

The power supply has circuit protection built in that automatically shuts it down when it's drawing too much current. A quiet internal fan cools the unit, which measures $9^1/_2$ by 6 by $9^3/_4$ inches and weighs approximately 10 pounds. The MFJ-4035MV power supply retails for $149.95.

MFJ ENTERPRISES, INC.
P.O. Box 494
Mississippi State, MS 39762
Tel: 800-647-1800 or 601-323-5869
Fax: 601-323-6551
e-mail: mfj@mfjenterprises.com
Web: www.mfjenterprises.com

Tri-Band Transceiver

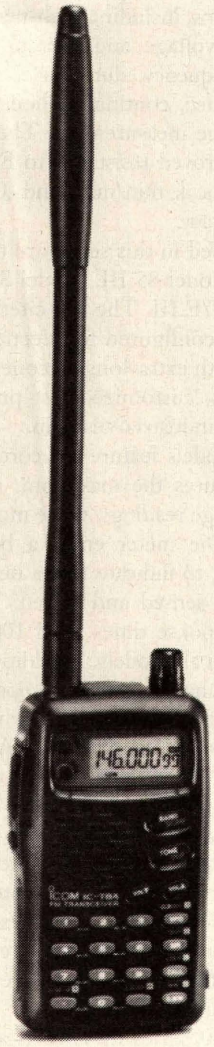
PRESENTED AS THE WORLD'S smallest tri-band handheld and the only one with 50-MHz coverage, the ICOM T8A weighs only 9.9 oz. and measures approximately $2^1/_4 \times 4^1/_4 \times 1^1/_8$ inches. The transceiver covers the 6-meter, 2-meter, and 440-MHz amateur bands, which include "receive" coverage of the popular aircraft-band, 150- and 450-public safety bands, and FM and TV broadcast bands.

The T8A's transmitter output power is 5 watts on all bands. Simply pressing the BAND switch selects the active band. It has a 123 memory capacity, including 10 scan edges and 1 call channel per band, arranged in 10 groups of 20 channels each. A variety of scanning methods are provided.

Tone squelch, pocket beep, and auto-squelch are standard features of the T8A, as is tone scan, which allows users to determine the subaudible tones required to access repeaters. The pocket beep feature also provides a "pager-like" function. The T8A also offers a DTMF decoder with nine DTMF memory channels.

Other features include auto-power saver, electronically controlled volume, and direct keypad input. A guide function allows display of the selected mode in the T8A's display window for convenient setup. This window has an LCD backlight with a timer. Power is provided by a lightweight Ni-MH battery pack. The transceiver is water-resistant and features a die-cast aluminum chassis for durability and reliability. The T8A has a suggested list price of $392.

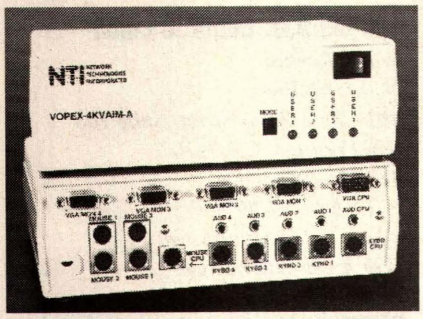
ICOM AMERICA
2380 116th Avenue NE
Bellevue, WA 98004
Tel: 425-454-1855
Fax: 425-454-1509
Web: www.icomamerica.com



CIRCLE 23 ON FREE INFORMATION CARD

Keyboard, Monitor, and Mouse Splitter

AUDIO CAPABILITY HAS BEEN added to the VOPEX-4KVAIM-A, a four-port keyboard, monitor, and mouse splitter. Now multiple users can connect to the same computer and use headphones to independently hear and interact with desktop presentations and electronic training software. Network managers who use these splitters to access servers from dual locations such as the office and the warehouse can bring the audio to both places.



CIRCLE 24 ON FREE INFORMATION CARD

Four keyboards, monitors, speakers, and mice are plugged directly into the VOPEX-4KVAIM-A. The computer peripherals can be placed up to 500 feet away by connecting extension cables between them and the splitter. All the VGA monitors show the same image, with guaranteed 1600 × 1200 resolution up to 250 feet. Access from the keyboards and mice is automatic upon typing or mouse movement.

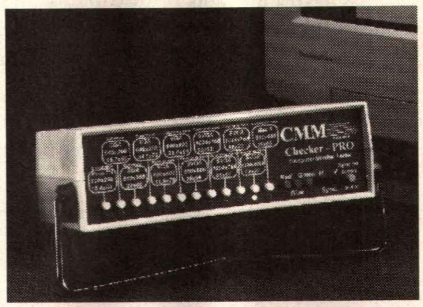
Audio output devices connect to 3.5 mm stereo jacks. Three-foot cables for connecting the VOPEX-4KVAIM-A to the PS/2 or compatible are included. The splitter—housed in a 8 × 6.2 × 2.6 plastic case—is powered by 110 or 220 VAC and retails for $515.

NETWORK TECHNOLOGIES INC.
1275 Danner Drive
Aurora, OH 44202
Tel: 800-742-8324 or 330-562-7070
Fax: 330-562-1999
Web: www.networktechinc.com

Computer Monitor Tester

DESIGNED FOR USE IN BOTH the field service and shop maintenance areas, the Checker Pro is a computer color monitor pattern generator that can check out almost any monitor. Problems can be isolated by directly connecting the unit to the monitor. The unit can be AC or battery operated.

The Checker Pro makes it easy to do testing and evaluating. It is no longer necessary to swap video cards or monitors or even open the computer for a diagnosis. Technicians no longer need to tie up a computer system to test or burn in a monitor. With sweep rates from 31.5 to 64 kHz, the Checker Pro supports Mono, CGA, EGA, MAC, and VGA modes.



CIRCLE 25 ON FREE INFORMATION CARD

On the bench, the tester offers great flexibility. Technicians can quickly switch modes using the pushbuttons, add sync on green, turn off any of the colors, and turn off either horizontal or vertical sync. The Checker Pro features various test patterns for VGA monitors. Its color bar/8-step gray-scale pattern allows color balance and tracking to be quickly evaluated and or adjusted. The Checker Pro has a suggested retail price of $499.95.

COMPUTER & MONITOR MAINTENANCE, INC.
6649-N1 Peachtree Industrial Blvd.
Norcross, GA 30092
Tel: 800-466-4411 or 770-662-5633
Web: www.computermonitor.com

Virtual Scope

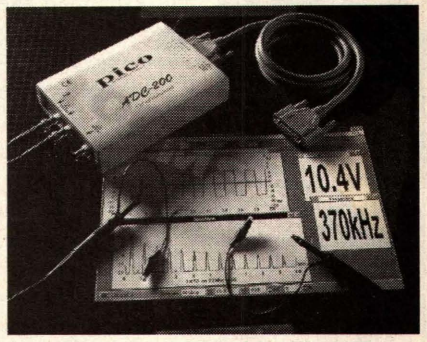
PICO TECHNOLOGY'S ADC200-100 virtual digital scope combines the functions of a 100 million samples/sec dual-channel digital oscilloscope and a 50-MHz spectrum analyzer in a PC-based virtual instrument. Performing all the operations of a standard oscilloscope and digital multimeter, the ADC200-100 uses its computer capability to annotate and save, as well as print traces in black and white or color, and to cut and paste waveforms into word-processing documents.

The PicoScope software supplied with the instrument provides simultaneous display of the oscilloscope, spectrum analyzer, and digital multimeter functions. In addition, the autoranging multimeter features simultaneous display of multiple parameters, such as true rms or DC voltage, dB gain, and frequency measurements.

Easy-to-use features include overlaying a live trace with a stored reference trace, plus on-screen help and pull-down menus. Powerful triggering modes help to capture intermittent or unusual events. The "Save On Trigger" option saves every trigger event to disk, complete with date and time stamp.

Identifying the source of noise on power lines, which is difficult with a standard oscilloscope, is simplified on the ADC200-100's spectrum analyzer. Even when there are multiple noise sources, the analyzer makes it easy to identify the signature of the noise and to determine its source. The 0–50 MHz spectrum analyzer range covers frequencies required for EMC-conducted noise testing.

With the ADC200-100, transferring the data to other applications such as spreadsheets is easy. Users can also automate data collection and analysis with the software drivers supplied.



CIRCLE 26 ON FREE INFORMATION CARD

Previously available in Europe, the ADC200-100 is now available in the U.S. for $799 from the Saelig Company.

SAELIG COMPANY
1193 Mosely Road
Victor, NY 14564
Tel: 716-425-3753
Fax: 716-425-3835
Web: www.saelig.com

EN

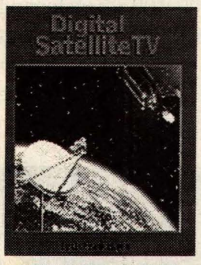
POPTRONIX®
Online Edition
We're on the web FREE
http://www.poptronix.com

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Digital Satellite Television

by Frank Baylin
Baylin Publications
1905 Mariposa
Boulder, CO 80302
Tel: 303-449-4551
Fax: 303-939-8720
Web: www.baylin.com
$50 plus $4 S & H



CIRCLE 338 ON FREE INFORMATION CARD

In this completely rewritten version of *Ku-Band Satellite TV*, Dr. Baylin has extensively revised and expanded the material, covering all aspects of worldwide digital satellite television systems. The book starts with the basics, including concepts of communication, digital modulation methods, the effects of noise and frequency allocations, and analog video and audio methods. Video compression, the MPEG-2 standard, DVB and channel encoding techniques are then discussed.

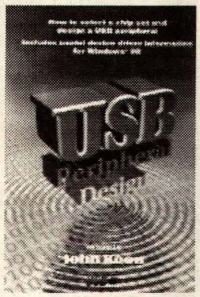
The author covers the components of a satellite circuit—the uplink, the satellite, and the receive site; geostationary satellites; and satellite design and operation. He goes on to discuss the current state and future trends in the design of both analog and digital satellite receiver. Other topics explored in this comprehensive 488-page manual are installation methods; upgrading systems from C- to Ku-band, from single to multi-feed operation and from analog to digital reception; and methods of designing and sizing dishes.

Conventional and IF distribution systems, mobile applications for satellite television, and troubleshooting and repairing satellite receive systems are all thoroughly reviewed. This comprehensive book is profusely illustrated with over 400 photographs and diagrams.

BooksNow To order books in this magazine or, any book in print. Please call anytime day or night: **(800) BOOKS-NOW (266-5766)** or (801) 261-1187 ask for ext. 1454 or visit on the web at **http://www.BooksNow.com/electronics now.htm.**
Free catalogs are *not* available.

USB Peripheral Design

by John W. Toon
Annabooks
111838 Bernardo Plaza Court, Suite 102A
San Diego, CA 92128
Tel: 800-462-1042 or 619-673-0870
Fax: 619-673-1432
e-mail: info@annabooks.com
Web: www.annabooks.com
$49.95



CIRCLE 339 ON FREE INFORMATION CARD

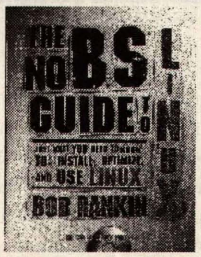
A complete overview of and practical guide for designing USB peripherals, this book answers the most common questions about the subject and refers readers to the resources needed to develop and test USB device drivers for Windows 95/98 and Windows NT 5.0. It is a complete reference manual for design, marketing, sales, and product managers and for device driver developers. Highlights of the latest USB Specification, a summary of USB features and operations, and application examples are included. Audio, video, and various device functions are defined.

It covers hardware and software components, including Windows 98, host and device side interlayer communication models, and use of generic drivers. How to design your own drivers, USB hub and device design considerations, power requirements, and numerous compatibility and testing issues are presented. The book also covers device, host, hub, and power ICs, as well as USB development tools and sources.

The appendix includes contact names and numbers for the leading suppliers of tools, hardware, and software required for USB peripheral design.

The No B.S. Guide to Linux

by Bob Rankin
No Starch Press
401 China Basin Street, Suite 108
San Francisco, CA 94107
Tel: 415-284-9900
Fax: 415-284-9955
e-mail: info@nostarch.com
Web: www.nostarch.com
$34.95

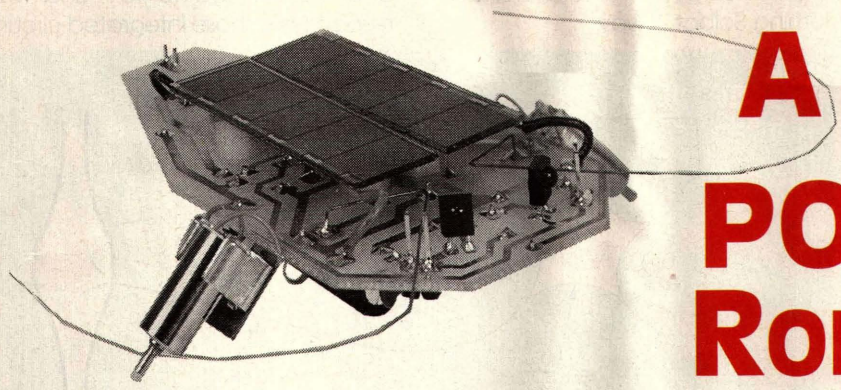


CIRCLE 340 ON FREE INFORMATION CARD

Previously those who were curious about Linux had to tackle bulky, technical books. This straightforward, easy-to-read guide tells readers just what they need to know to run and install Linux, and it is bundled with a complete copy of Linux on CD-ROM. The CD-ROM also contains the complete *Linux Encyclopedia*, as well as the Apache Web server and dozens of games, compilers, and utilities.

The author presents a concise treatment of installing Linux in ten easy steps; using the Bash shell; understanding the File System and navigating tree-structured directories; and listing files, creating and changing directories, and modifying command prompts. Explanations are given of running Windows programs and accessing DOS files, data manipulation—utilities for sending, searching, reporting, compression, encoding, and encryption—and configuring and using X Windows. Internet access and tools, reading and sending e-mail, using text editors, and running a Linux Web server are among the other topics discussed.

(Continued on page 59)



A SOLAR-POWERED ROBOT BUG

It creeps. It crawls.
It constantly searches for light on which to feed.
It's also as fun to watch as it is to build!

DAVID WILLIAMS

The concept of robots and robot design has captivated the mind and imagination of people since antiquity. Indeed, there have been kits, plans, and ready-assembled "mechanical servants" available for years. Robots from the ultra-simple to the extremely complex have graced the pages of many hobbyist and technical magazines, including **Electronics Now**.

The immediate image that the average person has whenever the term "robot" is mentioned usually leans toward the "mechanical man" design. Examples of that concept include Robby the Robot from the classic 1950's science-fiction film *Forbidden Planet* and the *Lost In Space* television series of the 1960's.

Robot design usually falls into one of three categories: mechanical devices that require human control for their operation, self-contained machines that follow an internal computer program, and simple "stimulus-response" units that use layers of simple electronic circuits and sensors to react to their environment.

It is that last category to which the subject of this article belongs. The *Solbot* presented here is an insect-like solar-powered robot. Although it has no computer and no provision for remote control, it has the ability to seek light and avoid obstacles.

Robot Behaviors. To mimic an insect's ability to maneuver in a real-world environment, the Solbot relies on autonomous "behaviors" that are organized into a control system. The most primitive of those behaviors is *explore*, which constantly urges the robot to move forward. However, with just that single behavior, it has no direction to its wanderings and no way to avoid being stuck. To give the robot more purpose, a second behavior, called *seek*, comes into play. That function lets the bug "see" light and move towards the strongest source. That can also be thought of as a "feeding" behavior, since the unit needs light falling on its photovoltaic cell for electrical power. To help the Solbot with the problem of being stuck, a third behavior, *avoid*, overrides the seek behavior.

That collection of three behaviors gives the control system a prioritized set of rules. The order of priority in the behaviors is designed to resolve any conflicts in the individual behaviors and coordinates a goal-oriented activity. In a sense, the system acts very much like a simple neural network.

Neurons. In living creatures, a nervous system organizes the reflexes in order to accomplish a task. The fundamental units of any nervous system are neurons. Neurons are nerve cells containing dendrites (inputs), a cell body (signal processor), and axon (output). An example of a neuron is shown in Fig. 1A. A neuron receives signals from other neurons through the dendrites. When a particular number of dendrites are stimulated in a particular way, the neuron "fires," sending an electrical impulse down the axon.

The cell body accumulates and grades all of the dendrite inputs through the surrounding membrane. Through a complex electrochemical process, each input has a "weight" associated with it. Those weights let each signal have a different influence in stimulating the neuron. In addition, some inputs can have negative weight that will inhibit the neuron from firing.

All of the inputs are combined and integrated over time. If a certain threshold potential is reached, the neuron will fire and send an impulse down the axon. The axon signal can trigger another neuron, stimulate a gland, or cause a muscle cell to contract, depending upon the neuron type.

Modeling Neurons. A block diagram of a neuron's function, and therefore the Solbot's nervous system, is shown in Fig. 1B. Two den-

drites are used for the light detection and obstacle avoidance sensors. The block diagram also shows the two functions of the "cell body"—the summing of the inputs and the threshold function for the output. The diagram also includes a motor-control output to match the axon in a biological nerve cell.

With that information, we can design a circuit that carries out the functions just described.

Circuit Description. The Solbot circuit, shown in Fig. 2, is an improved variation of a circuit originally designed by David Hrynkiw of Canada. Two identical circuits are used; the description applies to both halves. The circuit uses two high-efficiency solar cells, PC1 and PC2, to convert sunlight or ambient light into a DC voltage. That voltage is accumulated by charging C3 and C4. The two capacitors are wired in parallel, which doubles the effective capacitance of the circuit. The "explore" behavior mentioned before comes from that power source. In the dark, the Solbot will remain stationary, but in the light, it has an endless will to move.

The "seek" inputs are provided by photodiodes D1 and D2. The setting of potentiometer R5 and the intensity of the light falling on each photodiode determine the relative importance of each input with respect to each other. As the voltage rises across C3 and C4, current flows through R5, D1, and D2. That, in turn, charges C1 and C2. Since the photodiodes restrict the amount of current in relation to how much light that they "see," the voltage that appears on C1 and C2 will represent the amount of light seen by the photodiodes. The setting of R5 balances the circuit so that C1 and C2 will have the same charge if the amount of light falling on D1 and D2 is the same.

Switches S1 and S2 are the "avoid" inputs. If the Solbot's "antennas" brush up against an object in its way, one of the switches closes, depending on which side of the robot the obstruction is on. When the switch closes, either C1 or C2 discharges to ground through R3 or R4, respectively. That way, Solbot will "think" that there is no light in that direction. In a sense, the "seek" behavior has been overridden by the "avoid" behavior, turning Solbot away.

The voltages that appear on C1 and C2 are fed to IC1 and IC2, respectively. Those integrated circuits

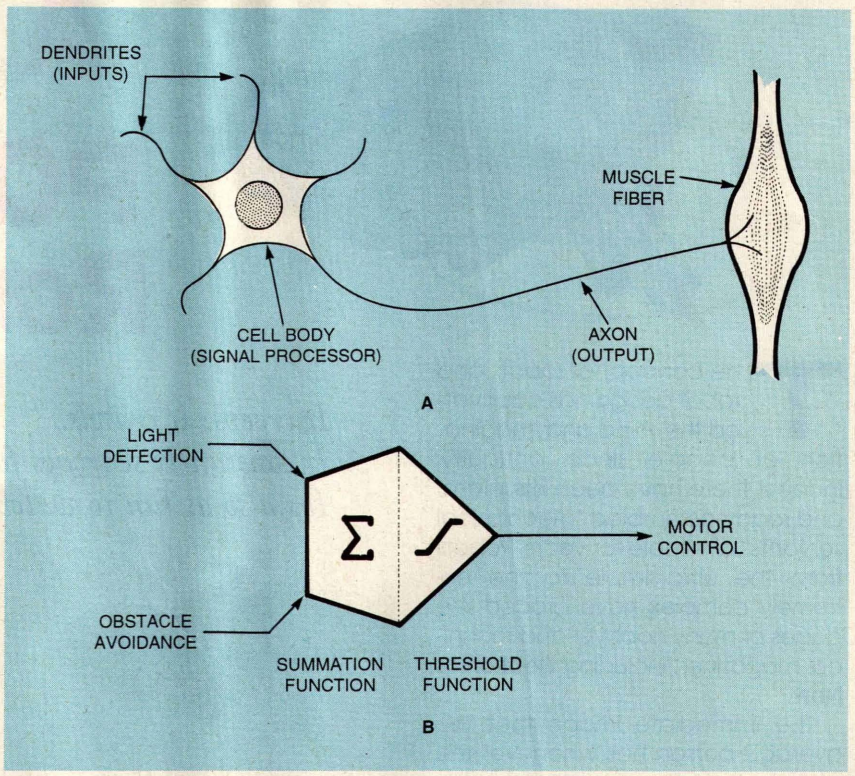


Fig. 1. In an organism (A), a nerve cell has several dendrites that serve as inputs. The cell body processes the inputs and "fires" when the right combination occurs. The output pulse travels down an axon to signal a muscle to contract. The entire process can be diagrammed schematically (B).

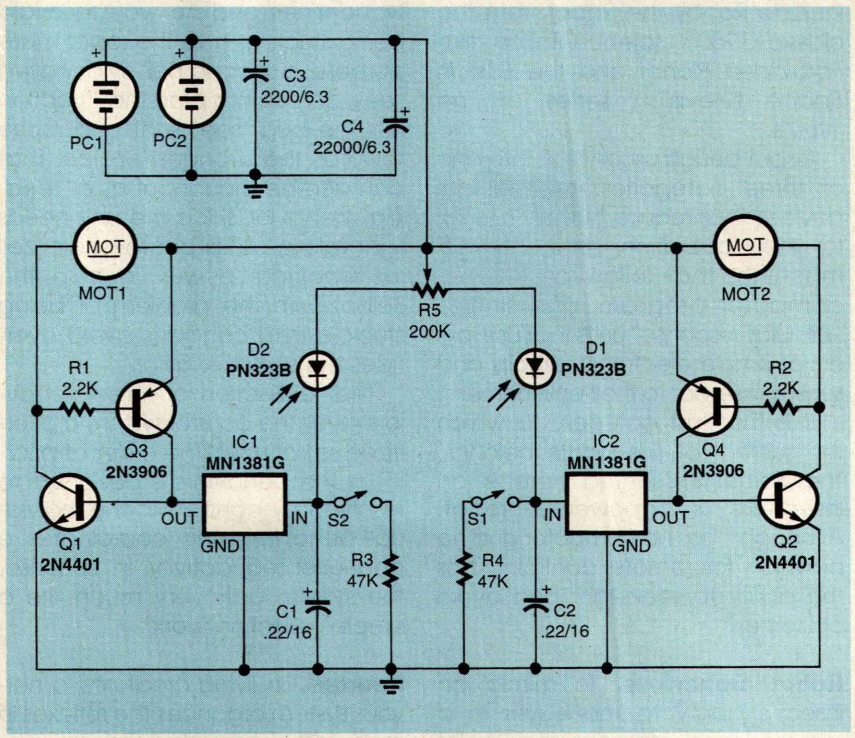


Fig. 2. The Solbot's circuit is a simple circuit that charges a pair of capacitors. When the capacitors reach a certain voltage level, the stored charge is dumped into a pair of miniature electric motors. If the ambient light is stronger on one side, the opposite circuit will charge faster, steering the robot in the direction of the light. The switches close when something is in the way; the robot will then move away from the obstruction.

were originally designed to be "power-on reset" circuits for microprocessor-based devices. Here, they are being used for threshold detection of the voltage on C1 and C2. When the input voltage on pin 2 of the MN1381s is less than 2.5 volts, the devices are "off"—their output pins are grounded. When the voltage on pin 2 rises above 2.5 volts, the device turns on, with the voltage on pin 1 equal to the input voltage on pin 2.

The output of each threshold detector goes to a motor-drive circuit. That circuit is the axon of the "electronic neuron." The drive circuits are designed to let the full charge of C3 and C4 flow through the motors. A single transistor is not sufficient, because as the voltage on C3 and C4 drops below 2.3 volts, the MN1381s will switch off and shut down the motor drive. To get around that limitation, two transistors and a resistor are used to form a circuit that acts like a silicon-controlled rectifier, or SCR. Once it is triggered, Q3 and Q4 will continue to supply current to Q1 and Q2. The circuit will stay latched on until C3 and C4 are discharged to about 0.7 volts. At that point, there is no longer a sufficient voltage drop for the silicon-based semiconductors to remain conductive.

Construction. The Solbot's circuit has no critical requirements in terms of layout; it can be hand-wired on a perfboard using standard construction techniques. However, an etched PC board will make it easier to position the motors and the antennas properly, as well as make for a neater and more professional look to the unit. If you choose to use a PC board for the Solbot, you can etch your own board using the foil pattern that has been included here. As an alternative, you can purchase a pre-etched board from the source given in the Parts List.

If you are going to use a purchased board or one made from the foil pattern, follow the parts-placement diagram shown in Fig. 3. Mount the parts to the board starting with the smallest ones. The following components should not be mounted to the board at this time: D1, D2, PC1, PC2, MOT1, MOT2, S1, and S2.

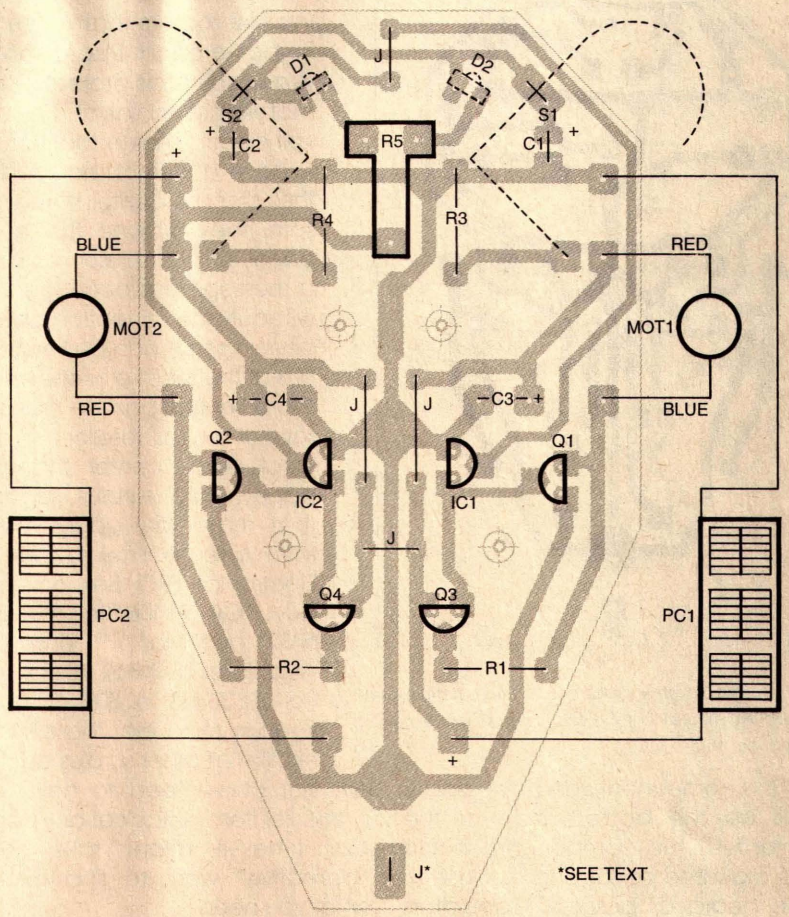


Fig. 3. Here is the parts-placement diagram for the Solbot solar-powered robot bug. All of the parts that are placed on the component side will be the unit's "underbelly." The jumper wire at the narrow end is a "skid" that holds up the robot's rear end.

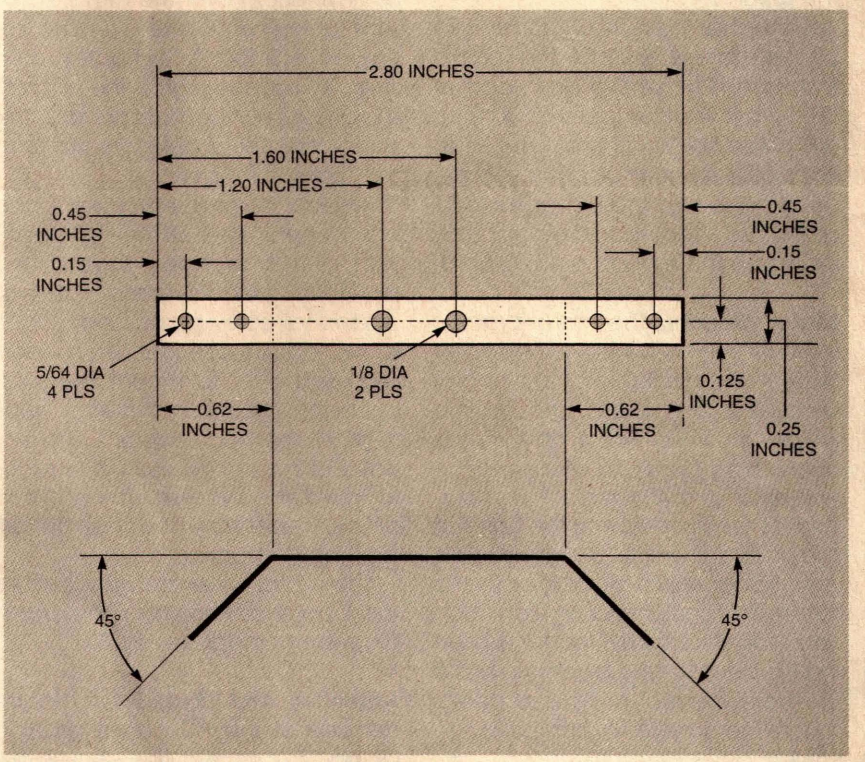
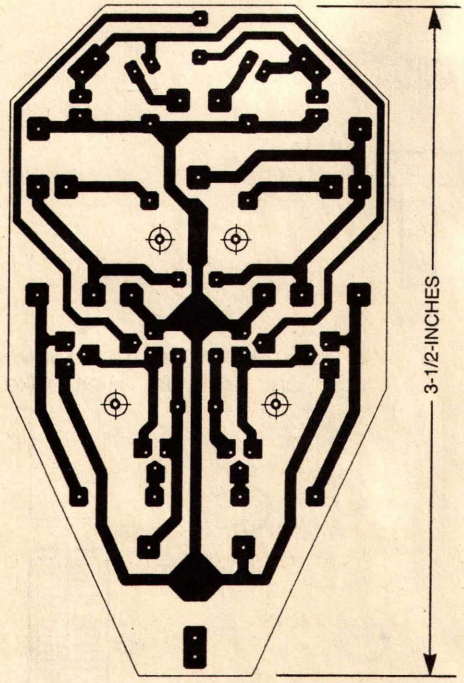


Fig. 4. The motor bracket is made from a strip of brass.



The Solbot is simple enough to be laid out on a single-sided PC board. Only a few jumpers are needed to build the unit.

The component side of the board will be the bottom side of the Solbot, so the components should be mounted as flat and as close to the board as possible. Capacitors C3 and C4 should be mounted laying sideways. If any components stick out too much, they will drag on the ground.

Note that there is a jumper wire at the narrow end of the board that doesn't seem to be a part of the circuit. That jumper wire is actually a skid-like "foot" that keeps the Solbot's belly from dragging on the ground. It is simply a U-shaped loop of solid wire that should be about ½ inch from the surface of the board.

Motor Mounts. The motor bracket is made from a ¼-inch-wide strip of brass that is available at any hobby shop. Cut the brass strip to the length shown in Fig. 4 and drill six holes. Using pliers or a vise, bend the two ends at a 45° angle. Fuse-holder clips are inserted into the holes at the ends of the strip. Bend their tabs and solder them in place. Use a larger-wattage soldering iron than you would normally use for soldering PC boards—the brass strip has a lot more thermal mass and needs much more heat to bring it up to soldering temperatures.

The fuse clips will be holding the motors that move the Solbot around. Pager motors are used in this project. Pager motors are miniature 1½- or 3-volt electric motors that normally have a weight mounted on their shaft off-center. When they spin, they vibrate the entire pager, letting the user know that a message has been received without the attention-getting beeping that can be so disruptive at the theatre or elsewhere. Those motors can be found at several surplus resellers or at a local repair center that fixes pagers. Two surplus suppliers that may carry pager motors from time to time include All Electronics (PO Box 567, Van Nuys, CA 91408, Tel: 800-826-5432) and Marlin P. Jones and Associates (PO Box 12685, Lake Park, FL 33403, Tel: 800-652-6733). Keep in mind that those suppliers, like all other surplus dealers, are not guaranteed to have any particular item in stock at any particular time—it might take some "detective" work to find exactly what you need.

The weights will not be needed for the Solbot—remove them. In their place, slip a ¼-inch length of rubber or vinyl tubing over the motor shaft. That tubing will act like a rubber tire, giving the Solbot extra traction on a smooth surface. With the motors snapped into the fuse holders, the entire assembly should look similar to the drawing in Fig. 5.

Attach the motor bracket to the component side of the PC board with a pair of nylon screws and threaded spacers, along with two additional screws and spacers as shown in Fig. 6. The four hex spacers are used later to mount the solar cells and the nylon material helps reduce the bug's weight. You will have to move C3 and C4 in order to install the barcket. Once it is in place, reposition the capacitors against the board.

The motor wires are attached to the board as shown in the parts-placement diagram, Fig. 3.

Antennas And "Eyes." On the solder side of the PC board, position D1 and D2 so that their lenses are facing towards the front of the robot. Carefully solder them to the board.

The contacts for S1 and S2 are made from a length of straight-pin header. Cut two sets of two-pin headers. mount them with the long pins sticking out the foil side of the board—the plastic molding will act like a "component body." Solder the headers in place and clip off the excess pin from the header's plastic base on the component side of the board.

PARTS LIST FOR THE SOLBOT SOLAR-POWERED ROBOT BUG

SEMICONDUCTORS

IC1, IC2—MN1381G, 2.5V Voltage Detector (Digi-Key MN1381-G-ND or similar)
Q1, Q2—2N4401 NPN transistor
Q3, Q4—2N3906 PNP transistor
D1, D2—PN323B photo-sensitive diode (Digi-Key PN323BPA-ND or similar)

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R2—2200-ohm
R3, R4—47,000-ohm
R5—200,000-ohm potentiometer

CAPACITORS

C1, C2—0.22-µF, 16-WVDC, electrolytic
C3, C4—2200-µF, 6.3-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

PC1, PC2—3-volt photovoltaic cells (Digi-Key P247-ND or similar)
MOT1, MOT2—Subminiature DC pager motor (see text)
S1, S2—2-pin header, straight-pin (see text)
1/64-inch-diameter brass wire, ¼-inch-wide brass strip, PC-mount fuse clips, wire, hardware, etc.

Note: The following items are available from LNS Technologies, PO Box 67243, Scotts Valley, CA 95067; Tel: 831-768-9155;Web: www.ccnet.com/~lnstech: Complete kit of all parts including etched and drilled PC board, solar cells, 2 pager motors, ICs, and all other components listed above, (SOLARBUG-KIT) $59.00; Miniature DC Pager Motor, (PAGER-MOTOR) $12.00 each; PC Board only, (SOLAR BUG- PCB) $10.00. Please add $5.00 for shipping and handling. California residents must add 8% sales tax.
MasterCard and VISA orders are accepted. No C.O.D. orders will be accepted.

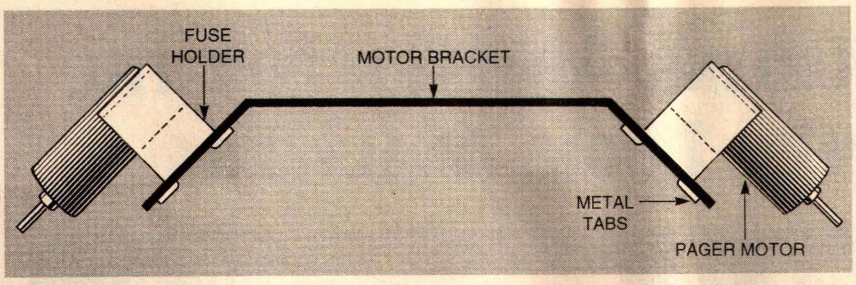


Fig. 5. The pager motors are clamped to the bracket with a pair of PC-mount fuse clips. Bend the tabs of the clips before soldering them—that will increase the strength of the unit.

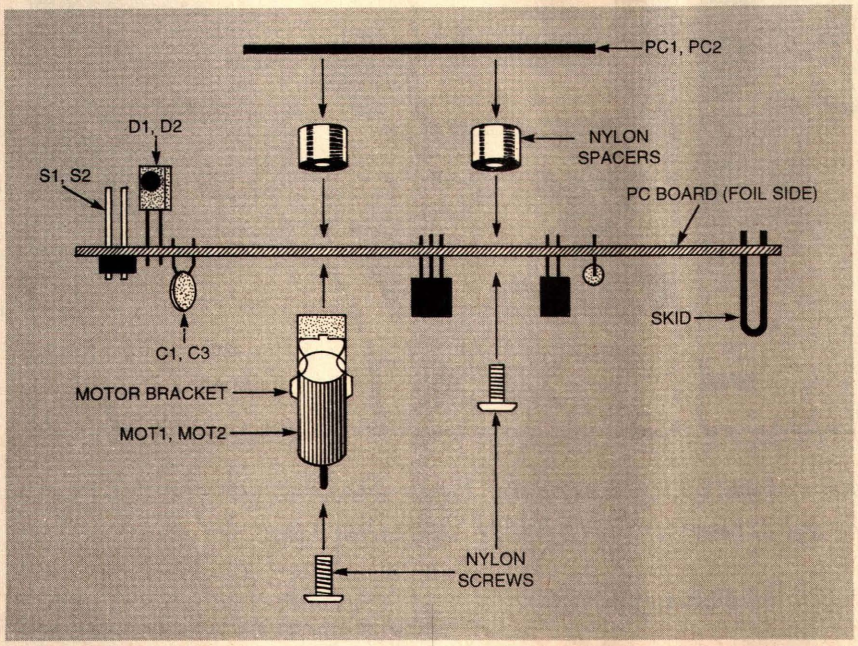


Fig. 6. Some of the Solbot's parts mount onto the foil side of the board, including its photo diode "eyes" and the "feeler" switches.

The "antennas" themselves are made from $^1/_{64}$-inch-diameter brass wire, which is available at the same hobby shops that carry the brass strip used for the motor mount. The diameter specified has just the right amount of spring. Cut two 6-inch lengths. Bend each piece to the approximate shape shown in Fig. 3. Start with a 90° bend about ½-inch from one end that will be soldered into the board later. Slip the wire into its hole in the PC board and make a second bend so that it passes exactly between the two header pins. The wire that extends beyond the headers is bent into a sweeping curve so that it looks like an insect's drooping "feeler" antennae.

Once the wires are shaped properly, solder them to the PC board. Make sure that they are not touching any traces on the board except where they are soldered. If needed, bend the wires so that they sit in between the header pins. If the wires are pushed to either side, they should make contact with the header pins. It is also important that the wires are below the top level of the nylon spacers that will be holding the solar cells.

The final step is to attach solar cells PC1 and PC2. Cut four 1-inch lengths of 26-gauge insulated wire and strip ¼-inch of insulation from all of the ends. It is a good idea to use different colors for the wires—two red ones and two black ones are the most logical. Solder the wires to each terminal of the solar cells; use the red wires for the positive terminals and the black wires for the negative terminals. You can use a voltmeter to identify the solar cell's polarity if you're not sure.

Glue the solar cells to the nylon spacers with epoxy or hot-melt glue. Once the adhesive is set, carefully connect the wires to the PC board, making sure that the antenna wires are free to move.

With the Solbot's construction completed, it is time to test the circuit.

Testing And Operation. Set R5 to its center position. Place the Solbot on a table or desk directly under a bright lamp. After several seconds of charging, the robot will make a quick lurch forward. It will charge for several more seconds before it will move again. Although it moves slowly back and forth in a crab-like motion, the robot will move toward the light source. Eventually, the robot will pass under the light and start to make a U-turn. Over time, in its constant attempt to reach the light, it will roam around in circles within a fairly confined area.

Test Solbot's light-seeking behavior by placing it first to the left of the light source and then to the right of the source. In each case, the robot should turn and move in the direction of the light. If Solbot tends to move in one direction only, you might need to adjust R5 to balance the sensitivity of D1 and D2. If you take the unit outdoors under the sun, it will move faster, but will head in a single direction only.

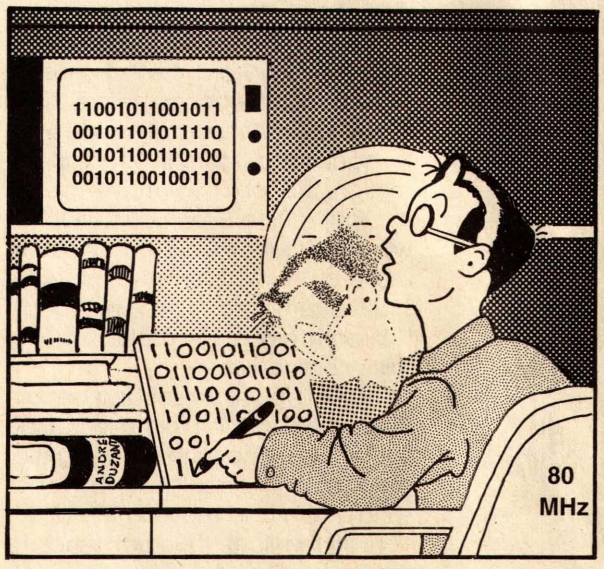
The Solbot will move tirelessly as long as there is a strong enough light source to charge the capacitors. In fact, you may have to store it in a drawer or closet to get it to stop! You might even consider building two or more Solbots and watch them "bug" each other! Ω

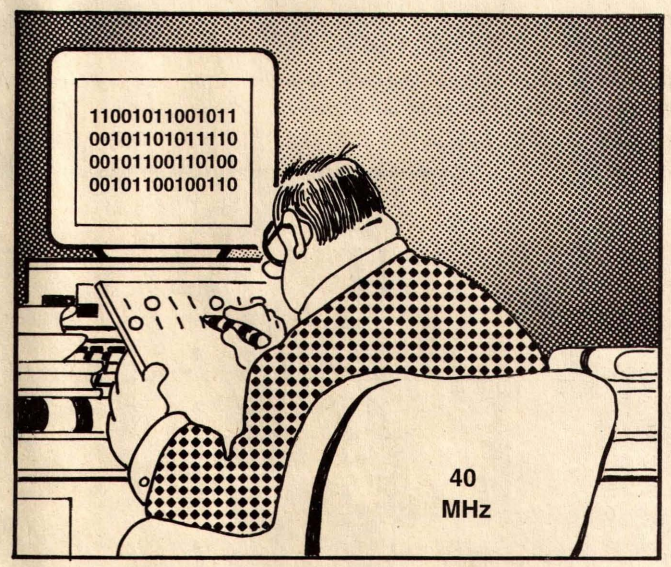
WINDOWS 95
—One Step at a Time

Don't know what to do when confronted with Microsoft's Windows 95 screen? Then you need a copy of ***Windows 95–One Step at a Time***. Develop your expertise with the straight-forward presentation of the frequently-used features that make Windows 95 so valuable to the PC user.

To order Book BP399 send $8.99 plus $3.00 for shipping in the U.S. and Canada only to **Electronics Technology Today Inc.**, P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery.

A Speed-Doubling Adapter for the High-Speed Logic Analyzer





With this simple adapter and enhanced software, the High-Speed Logic Analyzer can read data at an astounding 80-MHz sampling rate!

ROBERT G. BROWN

The High-Speed Logic Analyzer that was featured in the March 1998 issue of **Electronics Now** was designed to be expandable. One example of that feature was the Digital-Storage-Oscilloscope module that appeared in the May 1998 issue of **Electronics Now**.

Although the Logic Analyzer can sample signals at a 40-MHz rate, many users of the device have asked if the speed of the device can be increased. For those who have a "need for speed," the Speed-Doubling Adapter presented here is just what you've been asking for. With that adapter and a simple update to one of the programmable chips within the Logic Analyzer itself, you can capture samples at an 80-MHz rate. However, as with any performance gain in a piece of equipment, there is usually a tradeoff. In this case, the number of channels available for sampling will be reduced from 16 to 8.

How it Works. As you can see from the schematic shown in Fig. 1, the Speed-Doubling Adapter is a very simple circuit. There are only two ICs: a voltage regulator and a clocked latch. The eight data inputs are connected to P1. That connector replaces the original data connector on the High-Speed Logic Analyzer. The logic signals are routed to two locations. First, they are applied directly to channels 1 through 8 on the Logic Analyzer. Second, they are also applied to the input latches on IC1. The outputs of the latches on IC1 are then connected to channels 9 through 16 on the Logic Analyzer. The 5-volt power needed by IC1 is supplied by IC2, which gets its power from the Logic Analyzer's expansion connector.

The key to sample-rate doubling is on the Logic Analyzer board itself. Although additional circuitry has to be added to the Logic Analyzer, that circuit is contained completely within one of the programmable-logic devices (PLDs) within the Logic Analyzer—the GAL22V10. For a discussion of the Logic Analyzer circuit, see the **Electronics Now** articles mentioned above.

The situation here shows one of the advantages to using programmable logic in any circuit design. Whenever the design needs to be updated or modified, it is a simple task to reprogram the PLD. The changes we will be making to the Logic Analyzer will not affect the unit's normal operation in any way.

To get a sample rate of 80 MHz from a 40-MHz sampling clock, we must be able to take a data sample on both the rising and falling edges of the clock signal. We can do that by making the clock signal that appears on the Logic Analyzer's expansion port (pin 24 on connector P3) inverted in relation to the Logic Analyzer's main internal clock. That way, IC1 will be latching data from the input signals while the Logic Analyzer is getting ready to capture the next sample. When it does, the current state will be on channels 1–8, and the "half-clock" capture being stored in IC1 will be on channels 9–16. That is why we can only sample 8 channels instead of 16. Another tradeoff for increasing the Logic Analyzer's performance is that the Logic Analyzer's trigger circuit is still

running at the 40-MHz clock rate. That means that the trigger condition must occur for two data samples to be sure of a solid trigger.

Table 1 shows a new clock-selection chart for IC2 on the Logic Analyzer. The new additions are marked with an asterisk.

Building the Speed-Doubling Adapter. Although the circuit for the Speed-Doubling Adapter is very simple, it must be built on a PC board because of the high frequencies involved. You can either make your own PC board by using the foil patterns supplied here, or purchase a pre-etched board from the source given in the Parts List.

Follow the parts-placement diagram shown in Fig. 2. Start by mounting surface-mount capacitor C2 to the solder side of the board. It is located beneath IC1. If you want to use a socket for IC1, you can mount that item next. Continue construction by mounting the capacitors, IC2 and P1. Install P2 and P3 on the solder side of the board.

It is a good idea to check for proper power distribution before installing IC1. After carefully inspecting the board, plug it into the Logic Analyzer (of course the Logic Analyzer should be off when you do that). Turn on the Logic Analyzer and measure the voltage between pin 10 and pin 20 of IC1. Pin 20 should be at 5 volts. If IC2 is working correctly and supplying the proper voltage to IC1, you can turn off the Logic Analyzer, remove the Speed-Doubling Adapter, and install IC1.

You might need to update the GAL22V10 (IC2) on the Logic Analyzer board. You can check if IC2 needs to be upgraded by using the ALTADIAG program that came in the ALTALOG.ZIP archive that you obtained when building the Logic Analyzer. With the Speed-Doubling Adapter plugged into the Logic Analyzer and the Logic Analyzer connected to the PC, start the ALTADIAG program. Select low-level diagnostics by pressing F6. Once in the low-level diagnostics, select F1 in order to set the clock-select lines C0, C1, C2, C3, and C4. Enter the value 18. That selects the "self" clock as the system clock (see Table 1). Next, monitor the external clock sig-

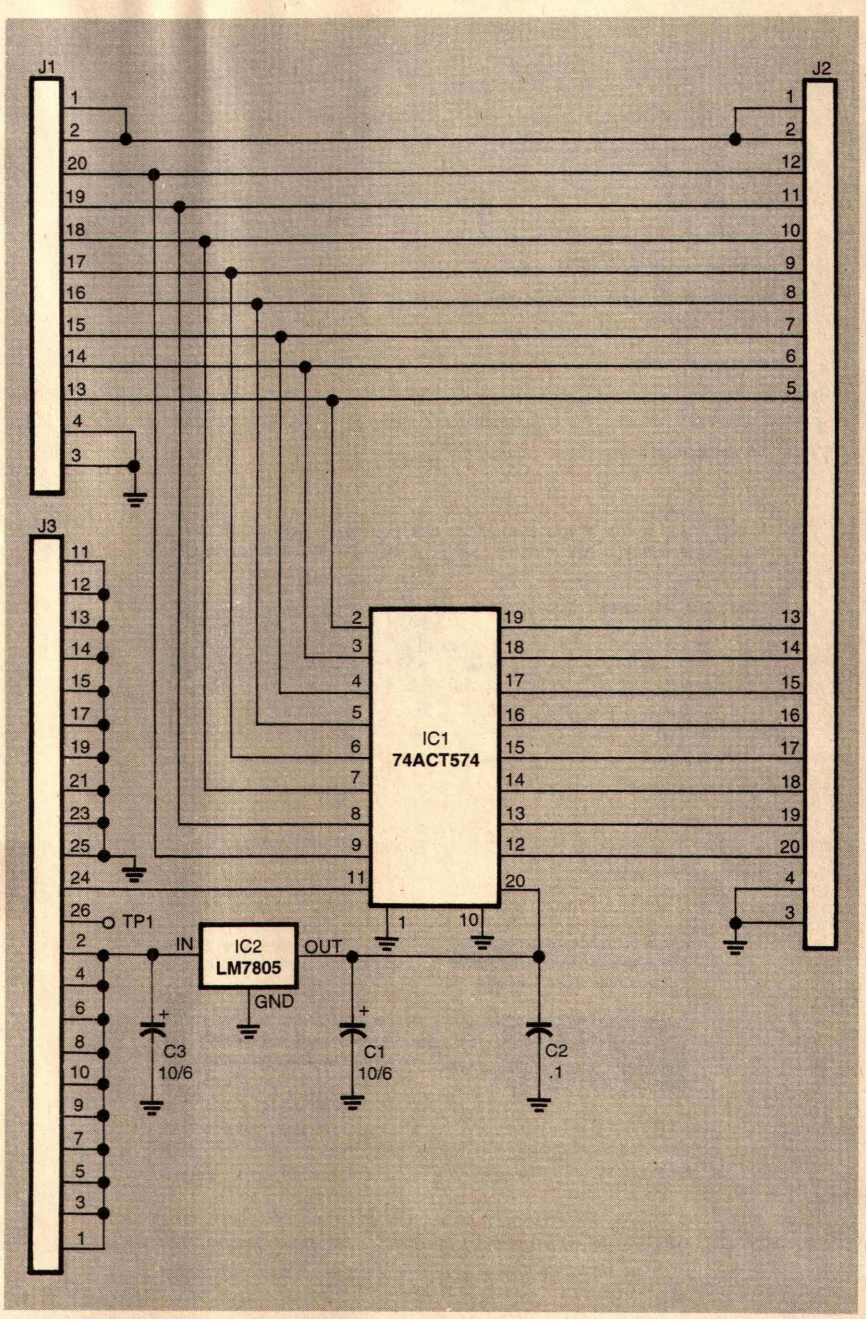


Fig. 1. The Speed-Doubling Adapter for the High-Speed Logic Analyzer uses a simple latch to capture additional samples between the normal capture cycles. The replacement PC software then combines the 16 channels of interleaved data into eight channels of high-speed data.

TABLE 1

C4	C3	C2	C1	MAINCLK	EXPCLK
0	0	0	0	40 MHz	MAINCLK
0	0	0	0	20 MHz	MAINCLK
0	0	0	1	10 MHz	MAINCLK
0	0	0	1	5 MHz	MAINCLK
0	0	1	0	2.5 MHz	MAINCLK
0	0	1	0	1.25 MHz	MAINCLK
0	0	1	1	0.625 MHz	MAINCLK
0	0	1	1	0.3125 MHz	MAINCLK
0	1	0	0	EXT clock	0
1	0	0	0	EXT clock inverted	0
*1	1	0	0	SELF clock	SELF clock
*0	1	1	1	40 MHz	INVERTED MAINCLK

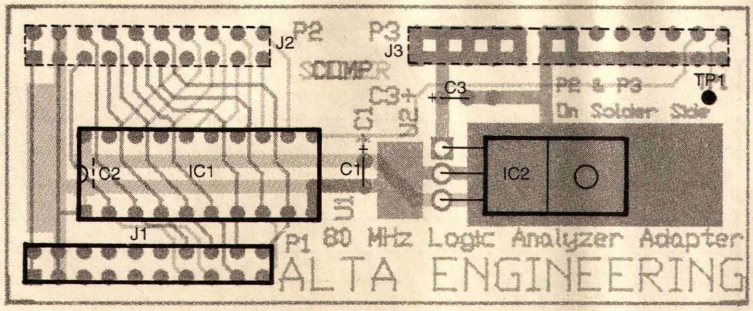
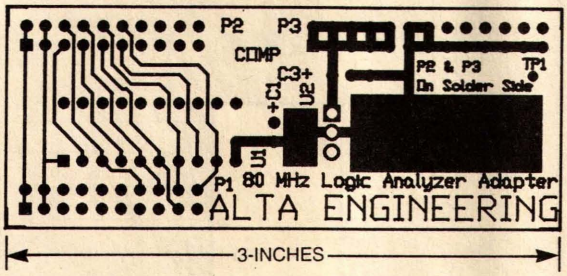
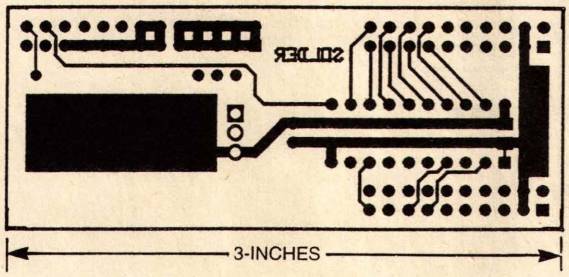


Fig. 2. Although the circuit for the Speed-Doubling Adapter is very simple, the high frequencies involved demand a PC board. This parts-placement diagram shows where to put those parts. Note that two connectors and one of the capacitors are mounted on the bottom side of the board. A simple piece of component lead can be used for TP1.



Here's the foil pattern for the component side of the Speed-Doubling Adapter. A double-sided board is needed to keep the unit small.



Here's the foil pattern for the solder side of the Speed-Doubling Adapter. If you make your own board, make sure to solder all components on both the component and foil sides.

nal at pin 11 of IC1 on the Speed-Doubling Adapter board. When you select F10, the internal "self" clock should toggle between high and low. If the external clock signal that you are monitoring also toggles, you do not have to reprogram the GAL22V10. If, on the other hand, the clock signal stays low, you need to reprogram the Logic Analyzer's IC2 according to the directions in the data sheet from the chip's manufacturer. Since the GAL22V10 is reprogrammable, you can simply reprogram the existing part. The source code for the new program is in the file ALTAL80B.EQN. That code, and all of the updated files needed for using the Speed-Doubling Adapter, can be found on the Gernsback FTP site at ftp.gernsback.com/pub/EN/altal80.zip. You will need to download that archive file whether you need to update your Logic Analyzer or not—a new program for the PC will be needed to use the Logic Analyzer at 80 MHz.

Testing and Using the Speed-Doubling Adapter. As mentioned above, the new program for using the Logic Analyzer at 80 MHz is called ALTAL80.EXE. It is included in the ALTAL80.ZIP archive file. You should place ALTAL80.EXE in the same directory as the ALTALOG.EXE program since they share the same configuration file. You use the same probe assembly for both the standard Logic Analyzer and the 80-MHz adapter. The probe assembly plugs into P1 on the adapter the same way that it plugged into the Logic Analyzer. When using the Speed-Doubling Adapter, only the ground probe and the D0—D7 probes are functional. With the Speed-Doubling Adapter and the probe assembly plugged into the Logic Analyzer, turn on the unit and start the ALTAL80 program. The program works in the same way as the standard Logic Analyzer program does, except that you are limited to 8 channels at an 80 MHz sample rate.

You can test the Adapter by connecting each of the probes one at a time to TP1 on the Adapter board. Acquire data with each probe and then view the data using the timing display. The timing display should show that the signal corresponding to the probe used has a waveform that is high for 128 samples and then low for 128 samples. Once you have verified the operation of each of the eight channels, you are ready to start

(Continued on page 44)

PARTS LIST FOR THE SPEED-DOUBLING ADAPTER

SEMICONDUCTORS

IC1—74ACT574 octal D-type flip-flop, integrated circuit
IC2—LM7805 5-volt voltage regulator, integrated circuit

CAPACITORS

C1, C3—10-µF, 6-WVDC, electrolytic
C2—0.1-µF, ceramic, surface-mount

ADDITIONAL PARTS AND MATERIALS

J1—20-Pin male header, straight pins
J2 – 20-Pin female header
J3 – 26-Pin IDC female head

Note: The following items are available from: Alta Engineering, 58 Cedar Lane, New Hartford, CT 06057-2905; Tel: 860-489-8003; e-mail: alta@compuserve.com;Web: www.gutbang.com/alta: software on 3½-inch diskette, $10.00; blank PC board only, $25.00; complete kit with software, $35.00. Please include $5.00 for shipping and handling within the US; $10.00 for shipping and handling outside the US. Visa and MasterCard are accepted.

MÖBIUS CIRCUIT

Experiment with a basic IC building block—the current mirror.

SKIP CAMPISI

Take a piece of typing paper or notebook paper and cut a ½-inch-wide by 11-inch-long strip from it. Bend it in a circle as shown in Fig. 1A so that the ends overlap slightly. Tack them in place with a bit of tape. You will end up with a paper hoop that is about 3 inches in diameter and ½-inch wide.

If you cut that hoop lengthwise along its circumference and centered between its edges, you will, of course, end up with two separate hoops. Each will be about ¼-inch wide and about 3 inches in diameter.

Make another paper hoop of the same dimensions, only this time twist one of the ends by 180° as shown in Fig. 1B before tacking them together. You will end up with a hoop that has a twist in it. Now if you cut the hoop lengthwise down its center, you will *not* get two hoops! Instead, you will get *one* hoop that is about 6 inches in diameter and ¼-inch wide.

You can keep cutting that twisted hoop repeatedly, and still end up with only a single hoop that is larger and narrower with each cut. Each cut will also double the number of twists in the hoop. That type of hoop is called a *Möbius Strip*, named after the nineteenth-century German mathematician August F. Möbius, who was the first to study the strange properties of that object.

The Möbius Strip has some other unusual properties: it has only one edge and one side! You can prove that by taking a pen or pencil and drawing a line around the hoop. Continue the line until you return to your starting point, and you will see that you have covered the entire strip, including what appears to be "both" sides. In essence, you have traveled a 720° circle!

Of course, the unusual properties of the Möbius Strip are due to the "twist" (through another dimension, if you will) in the hoop. That is called a *node* or *singularity*. In the language of mathematics, it is considered a pole of high order. The branch of mathematics that deals with unusual objects such as that is called *topology*.

Another classic example of topology is the *Klein* bottle. That object has two singularities and manages to be "inside" itself! If you are interested in discovering more about those and other unusual objects, read an introductory book on topology, which should be available at your local library.

You might ask, "How does topology relate to electronics?" By examining a very basic building block of integrated-circuit design, you will see how a singularity solves many design problems. Mind you, a true "topologist" might not agree with our analogy as applied to electronics, but it does work for our purposes.

The Möbius Circuit. Looking at the circuit shown in Fig. 2A, note that Q1 has its collector shorted to its base. That is called a *diode-connected* transistor. Since Q1's collector-to-base voltage is zero, it is still in its "active" mode of operation. In addition, having Q1's and Q2's bases and emitters connected together results in their having the same base-emitter voltage.

Resistor R1 supplies a fixed-bias current to Q1, resulting in a base-emitter voltage of about 0.6 volts for a silicon transistor. That voltage biases Q2 into conduction. For the time being, we will assume that both transistors are matched exactly for both base-emitter voltage and gain, and that the current gain is extremely high.

As the base-emitter voltages for Q1 and Q2 are equal, so then are the base and emitter currents. Thus—and here is the essential point of the circuit—the *collector* currents are exactly equal in both transistors when Q2 has a load within its "compliance" range. With an extremely high gain, the base currents are negligible and the collector current of Q2 equals the current through Q1.

Using conventional current flow (flow from a positive terminal to a negative terminal) to describe the circuit response, we can state that the source current from R1 is "mirrored" by Q2. The same magnitude of current is being sinked by Q2 at its collector. Thus, the term "current mirror" is applied to that type of circuit.

The "compliance" range of Q2 mentioned before, in which its sink current is equal to the source current, can be anywhere from +V to 0.6 volts. If the voltage drops below 0.6 volts, Q2 will have a negative bias on its collector-base junction. For example, shorting Q2's collector to +V (a zero-ohm load) is viable, as is using a resistive load sufficiently high in value to drop +V to 0.6 volts at the load (or source) current set by R1.

The value of R1 is set by the same formula:

$$(+V - 0.6V)/I_{sink}$$

Of course, the transistors selected must be able to handle the desired current. The basic current mirror circuit indeed has a "singularity" all its own—the base-emitter voltage (0.6 V) that is being shared by Q1 and Q2.

With perfect components and matching, no matter what we do to the output circuit at Q2, the singularity will not change. It remains at its predictable voltage with any load.

The circuit shown in Fig. 2B shows another example. Transistors Q3 and Q4 have been added in parallel with Q2. Each of those additional transistors can now sink the same amount of current along with Q2. By connecting the collectors of Q2, Q3, and Q4 together as shown in Fig. 2C, we can now sink a current that is three times the size of the input source current. That is because the Q2-Q3-Q4 "composite" transistor now has three times the chip area of a single transistor.

Indeed, when fabricating integrated circuits, current mirrors actually use transistors with various chip areas to provide different magnitudes of current all over the IC. That is typical of "current-steering" networks. The current mirror makes an ideal current sink (with NPN units) or source (with PNP units). Either circuit is easily fabricated on a monolithic chip.

As you have seen, our "Möbius" circuit has some unusual (and desirable) qualities, although we have stretched a point in considering it with the topological analogy. Right now, it might seem to be an "ideal" circuit, allowing a large number of paralleled outputs with perfect responses. However, in the real world, that is never the case.

As we will see in the following breadboard experiments, factors such as base-emitter voltage and gain matching, temperature tracking, and output resistance affect circuit performance to various degrees. We will also present some circuit modifications to greatly improve our results.

If you want to learn more about bias voltage, bias current, and temperature effects on semiconductor junctions, or would just like to "bone-up" a bit on the background, refer to the author's article "Semiconductor Diode Guidebook" that was published in the June 1997 issue of **Popular Electronics**. That will help you understand the concepts presented here and the experiment results.

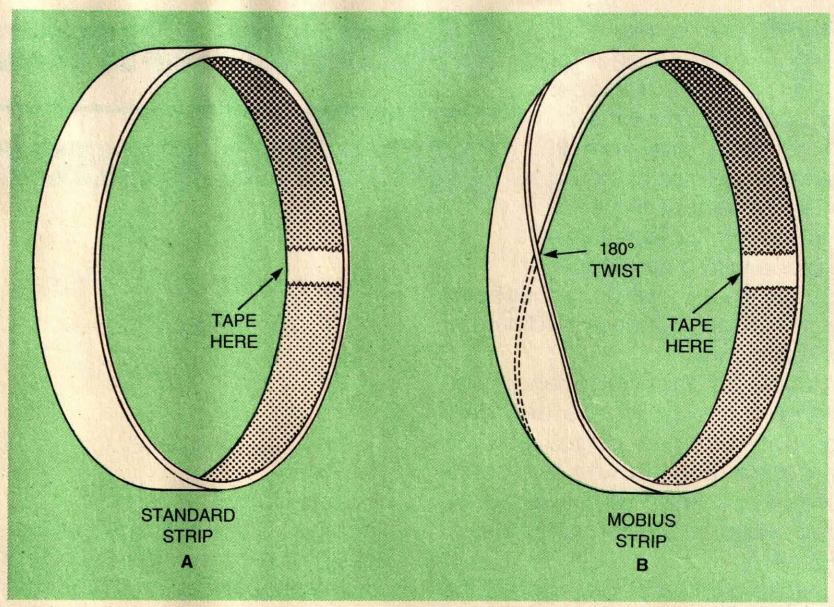


Fig. 1. Taping a strip of paper into a loop does not demonstrate anything interesting (A), but if you put a twist in it before joining the ends, you end up with a model of a Möbius loop (B). A Möbius loop has several interesting properties, including one side, one edge, and the ability to travel 720° before reaching your starting point!

Designing Current Mirrors. The best place to start our experiments is with standard discrete transistors. The only equipment needed is a small solderless breadboard, a standard 9-volt battery, a few ¼-watt resistors, and a few transistors.

If you already have a handful of general-purpose transistors, all bearing the same part number, you are ready to proceed. If not, NPN types such as a 2N3904 or 2N2222 are available in 10- or 15-piece packages at very low cost. Likewise, PNP types such as a 2N3906 or 2N2907 are similarly available. Any type will work in the circuits with which we will be experimenting.

Our first experiment will try to match up a pair of discrete transistors. With any luck, you might find a good match out of 10 pieces! However, a good match is not needed for valid results. Refer to Fig. 3A for NPN units or Fig. 3B for PNP units and set up the simple current-mirror circuit on a breadboard, using 22-gauge solid-wire jumpers where needed.

Starting with an 8200-ohm value for R1, the input reference current will be

(9.0 volts–0.6 volts)/8200 ohms

or roughly 1 mA. Connect ammeter M1 in series with R1 and apply power to the circuit. Make a note of the actual current measurement. Now change R1 to 82,000 ohms and repeat the test.

You should now see a reading of about 100 microamps; record that reading, also. Remove M1 from the circuit, making sure to re-connect R1. With Q2's collector terminal open, measure the voltage drop across the base-emitter junctions of Q1 and Q2, which will be at about 0.6 volts.

Short Q2's collector to +V (for the NPN version) or ground (for the PNP version). There should be a 10- to 20-mV increase in the base-emitter voltage drop. That is a result of the finite gain and output resistance of transistors, which in the real world have non-ideal characteristics. We will demonstrate the results of that increase shortly.

Connect M2 (again, using an ammeter) in series with Q2's collector terminal and note the output current with R1 still at 82,000 ohms. You should see a reading somewhere in the realm of 100 microamps. Now try substituting another transistor for Q2, using the same part number. Again, note the output current. After handling any of the transistors, always let the circuit temperature stabilize for correct measurements.

Add the original transistor in parallel to the current Q2 and note the output current, which should be close to the sum of your previous readings. Go back to one unit for Q2 and try substituting a few more units in the same way to see if you can find a transistor that matches Q1. If you get within 10% or 20%, you're rather lucky!

Once you find your "best match", change R1 back to 8200 ohms for a 1-mA reference current. The match between the transistors at that current level should be the same as you had at the 100-microamp level. Don't expect an exact correlation. While monitoring the output current, touch Q1 with your fingertip. The output current will "nose-dive" because of the drop in Q1's base-emitter voltage affecting Q2's bias level.

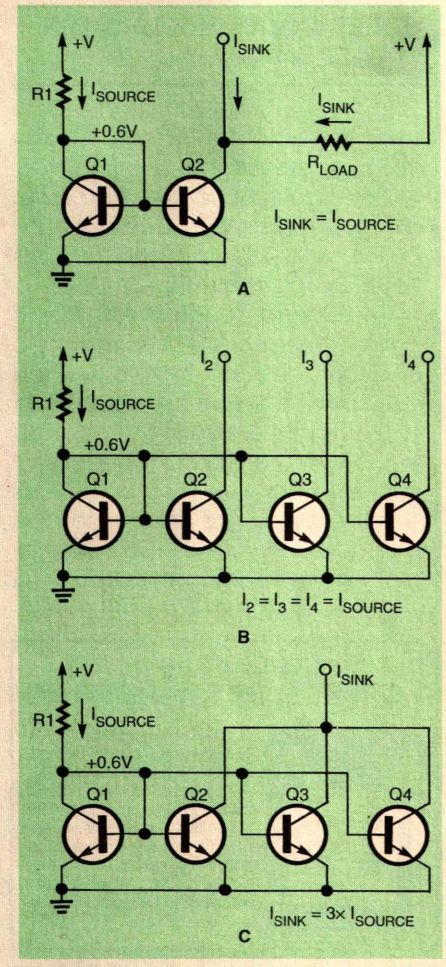


Fig. 2. Current-mirror circuits can come in several variations to meet certain needs. A basic mirror circuit (A) is one where the output current will always match and follow any changes in the input current. Multiple independent outputs (B) can follow a single input, or they can be ganged together (C) for a multiplying function.

That voltage decrease just barely changes the reference current, but drastically affects the output current! Now touch Q2 and note the opposite effect—the output current rises rapidly as Q2's effective bias point decreases, while the net base-emitter voltage remains constant, along with the reference current.

Obviously, temperature tracking between both transistors can be a huge problem using discrete units. Of course, using a common heat sink or even bonding the units together will help a great deal. However, the best solution is to use units that have been fabricated on the same substrate and mounted in the same package. We'll be discussing more on that technique later.

Using our "matched" circuit from above, we will next demonstrate the effects of finite gain and output resistance mentioned before. With the temperatures of both transistors stabilized, again measure and note that the output current is about 1 mA.

The circuit will be modified by adding R2 as shown in Fig. 3C, which shows the NPN version of the circuit. If you are working with the PNP version of the circuit, R2 is added in a similar fashion.

Use a value of 1000 ohms for R2. Note the output current. Now increase R2's value by about 2000 ohms and again note the resulting output current. Keep increasing the value of R2 and take measurements of the output current until you reach about 7500 ohms. At that point, the transistors should be near their maximum compliance voltage at that current level. You will soon see that as the value of R2 is increased, the output current decreases by 20% or so with typical transistors over the compliance range. That is caused by the limited output impedance of the circuit that is in parallel with R2. An ideal current source or sink requires infinite output impedance for true constant-current generation. That circuit typically has an output impedance in the range of 100,000 ohms or so. We really need to have an impedance value in the high-megohm range to achieve true accuracy.

As you have seen, our "Möbius Circuit" is a very simple and effective current generator. However, it leaves a lot to be desired as far as accuracy is concerned. Now we will look at some circuit improvements that will come closer to the "ideal" current mirror.

Going Further. Two of the major problems with our current-mirror circuit are temperature tracking and good matching between the transistors. Both problems obviously make output accuracy and predictability unreliable. Fortunately, several types of integrated circuits are available with matched transistors all on the same substrate.

Various degrees of matching are available from manufacturers such as Harris Semiconductor, National

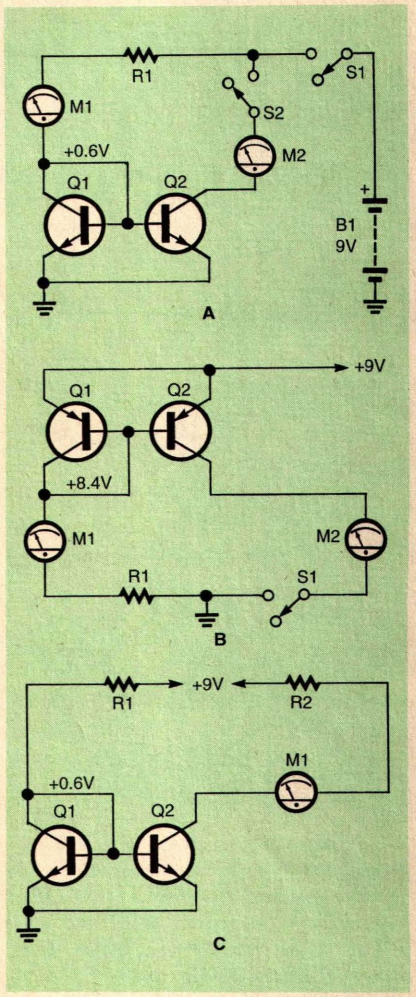


Fig. 3. In order for a current mirror to work correctly, the transistors must be "matched." A simple circuit for NPN transistors (A) or PNP transistors (B) let you easily test the variations in individual transistors. Once you have a "matched" pair, the circuit in (C) will show what happens because of a transistor's "finite" gain.

Semiconductor, and NTE. They offer multiple configurations in DIP packages, as well as dual units in TO-78 packages. Those devices, of course, have excellent temperature tracking along with the matching.

Dual transistors such as the 2N3810 (PNP) and 2N2920 (NPN) are available, and are also available from NTE. A good surplus dealer might also carry them. One surplus source for the 2N5117 dual PNP matched pair and the MAT-04, a matched NPN quad is Johnson Shop Products, P.O. Box 2843, Cupertino, CA 95015 (408-257-8614). The devices are very inexpensive. Try them in our breadboard circuit and note the vast improvement in accuracy!

Another temperature-related

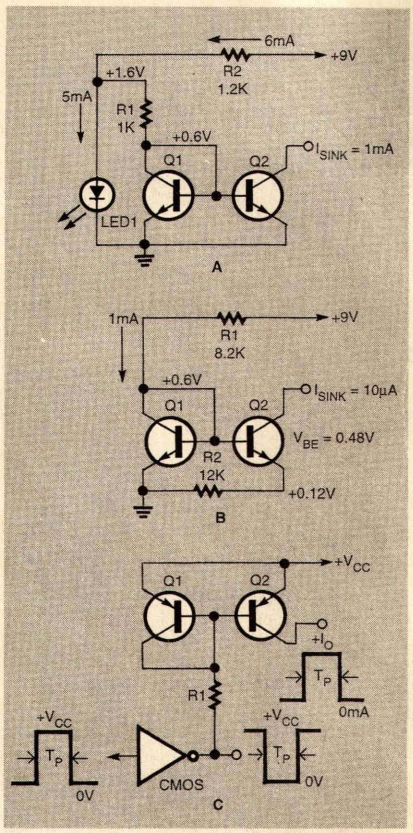


Fig. 4. Current mirrors are extremely sensitive to temperature changes in the transistors. Two different approaches are shown in (A) and (B) to compensate for temperature drift. The circuit in (C) shows how current mirrors can be "gated" on and off at extremely high speed.

problem is the drift caused by the temperature coefficient of Q1, which alters the base-emitter voltage and thus, the reference current. That can be corrected by the use of additional components as shown in Fig. 4A. A standard red LED is biased at 5 mA, resulting in a 1.6-volt drop across the diode. As Q1's base-emitter voltage is at about 0.6 volts, 1 volt appears across R1. The temperature coefficients of LED1 and Q1 are similar, and subtract out of Rl's voltage drop; thus, good compensation can be expected.

The reference current is calculated simply by dividing the value of R1 into 1 volt. An added bonus of the circuit is that much smaller values can be used for R1. That is very desirable where low values of output current are needed. Normally, the values of R1 would be quite high.

Fortunately, there is another method to provide very low currents and keep R1 to a reasonable value. The circuit shown in Fig. 4B is called a *Widlar* current mirror. Note that another resistor, R2, is in the emitter circuit of Q2.

Let's say that the reference current is set at 1 mA with R1 at 8200 ohms and that you need an output current of 10 microamps. Without R2, you would need a value of 820,000 ohms for R1 to do that. However, by including R2, we can reduce the base-emitter voltage applied to Q2.

The output current is an exponential function of the base-emitter voltage. For about every 60-mV decrease in voltage, the output current drops by one decade. If we select R2 to drop 120 mV at 10 microamps, the output current should be close to 10 microamps. Breadboard that circuit using a value of 12,000 ohms for R2.

Note that you will indeed have an output close to 10 microamps with dramatically lower resistor values. Also, check the output over its compliance range and note the improvement in accuracy. The Widlar mirror offers higher output impedance. Other circuits use another transistor to supply the base-current drive for Q1 and Q2 to reduce the output resistance and bias errors. Refer to a good college text on the subject for further information.

Our final current mirror example demonstrates the high speeds attainable with current generators. In those situations, discrete current sources or sinks have a great advantage over op-amp-based designs. The circuit in Fig. 4C shows how easy it is to "gate" a current mirror.

A standard CMOS gate of any type that is able to handle the reference current simply drives R1 directly. The rise and fall times are set by the CMOS gate. If you are interested in a high-precision gated-current source, refer to the author's article "Dual Scope Adapter" in the June 1996 issue of **Electronics Now**. That circuit uses a 2N5117 transistor that is driven by an op-amp and gated at high speed; it is used as an integrator.

As you have seen, the current mirror is an extremely versatile circuit, and just might be classified as a "Möbius" circuit. It definitely seems to have a singularity when you consider the importance of the base-emitter voltage. Why not try it in your next project design? Ω

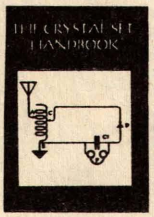
SPEED-DOUBLING ADAPTER

(continued from page 40)

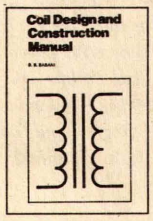
using the system. If you want to run the Logic Analyzer at 40 MHz, simply remove the adapter with the power off, plug the probe assembly back in the analyzer unit and run the ALTALOG program instead.

The Speed-Doubling Adapter is another useful addition to the Logic Analyzer for those situations when you need to view a few signals with a greater time resolution than you could with the standard analyzer. If you have any questions, comments or suggestions, the author can be contacted at 860-489-8003 or by e-mail at alta@compuserve.com. Ω

Get your copy of the
CRYSTAL SET HANDBOOK



Go back to antiquity and build the radios that your grandfather built. Build the "Quaker Oats" type rig, wind coils that work and make it look like the 1920's! Only **$10.95** plus **$4.00** for shipping and handling. **Claggk Inc., P.O. Box 4099, Farmingdale, NY 11735.** USA Funds ONLY! USA, Canada and Overseas.NY State residents add local sales tax. MA01



YOU CAN WIND YOUR OWN COILS?

There's no trick to it except knowing what you are doing. In a unique, 106-page book you can become expert in winding RF, IF, audio and power coils, chokes and transformers. Practically every type of coil is discussed and necessary calculations are given with the mathematical data simplified for use by anyone. Get your copy today!

Mail coupon to:

Electronics Technology Today, Inc.
P.O. Box 240
Massapequa Park, NY 11762-0240

Please send me my copy of *Coil Design and Construction Manual* (160). I enclose a check or money order for $8.95 to cover the book's cost and shipping-and-handling expenses. NY state residents must add local sales tax.

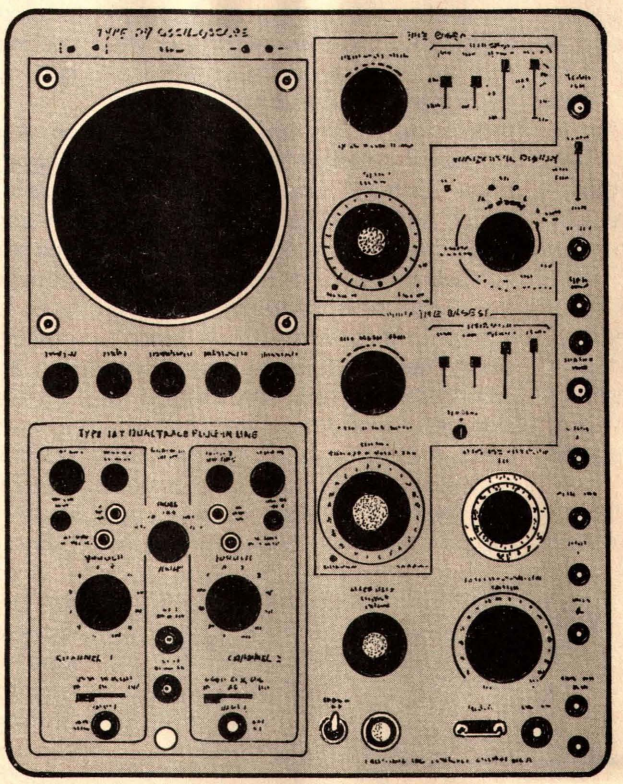
Name _____

Address _____

City _____ State _____ ZIP _____

All orders must be paid in U.S. funds only. Sorry, no orders accepted outside of USA and Canada. Please allow 6-8 weeks for delivery.

FAST BUT FORGOTTEN



Despite the fact that many modern engineers have never seen one, the once popular sampling oscilloscope is still one of the fastest display devices available.

TOM NAPIER

These days about equal numbers of digital and analog oscilloscopes are being sold. One reason is that the technology of analog-to-digital conversion has advanced to the point where it is cheaper to achieve display bandwidth by sampling a signal and storing it in memory than by displaying it directly on a CRT. Besides, once a signal is in numerical form, it can be processed in many useful ways. For example, it can be averaged to remove noise or its frequency spectrum can be computed.

One problem with digital oscilloscopes is that they must be used with care because of *aliasing*, something that has no counterpart in an analog scope. If the sampling rate is set to a frequency that is close to the repetition rate of the input signal, the display will show the correct waveform. However, it will indicate a time scale that is much slower than the true one and the display may even be time reversed. If the sampling rate is close to a multiple or submultiple of the data rate, the resulting display looks like a combination of several signals and is difficult to interpret.

Can Aliasing Be An Advantage? Aliasing isn't always bad. Back in the middle 1950s a fast transistor, or a good oscilloscope for that matter, had a bandwidth of 5 MHz. (Or 5 Mc/s as it was called then.) Integrated circuits didn't exist, and if you had asked an engineer to design a fast amplifier he would have used vacuum tubes. Despite that, some people were building oscilloscopes that had an effective bandwidth of 300 MHz. They used a few diodes, a few transistors, and a trick or two.

Their secret was a sampling circuit that could measure signal amplitude in a nanosecond or two. If the input was a pulse that was repeated at regular intervals, then successive samples could be taken from different pulses. If each sample was taken from a different place on each pulse, you could build up a picture of its shape without using any really fast electronics.

Because the sampling ran just a bit slower than the repetition rate of the input, it generated an alias of the input signal. The amplitude samples, which were being taken perhaps every 10 ms, were stretched until they could be displayed on a cheap oscilloscope with a bandwidth of about 1 MHz. That technique was described in the *Proceedings of the British Institute of Electrical Engineers* in 1959.

Using A Sampling Scope. The early sampling scopes were improved upon, and in their heyday they could display signals up to 10 GHz. They remain the fastest signal-display devices available, although few modern engineers have ever seen one. I first used a sampling scope back in 1983 while developing a 1.6 gigasample-per-second analog demultiplexer for the front-end of a digital oscilloscope.

That device was built as a thick-film hybrid on a substrate that measured about 1.5 by 2.5 inches. It had a pair of 5-GHz transistors whose bases were driven in antiphase by an 800-MHz sinewave. That switched their common-emitter current, the input signal, to both collectors in turn. Two more transistor pairs demultiplexed those current pulses at 400 MHz. The result went to four four-way demultiplexers whose transistors were driven by individual base-voltage pulses. The sixteen current pulses charged capacitors that drove sixteen 100-megasample-per-second digital-to-analog converters.

The device had to be checked out by probing inside it. A sampling scope was the only thing fast enough to do the job. The design worked after a fashion, and it convinced my superiors that it was worth developing as a custom chip. That company is now one of the world's biggest manufacturers of digital oscilloscopes.

That experience with a sampling scope came in useful about three years ago when I was a member of a team designing a receiving system to demodulate and decode the signals from the EOS series of Earth resources satellites. That equipment ran at data rates up to 210 Megabits-per-second, and the circuit board that was being developed was jam-packed with 300k series ECL logic chips. It also used two flash analog-to-digital converters that were sampling the input data 420 million times per second. Each bit was shorter than the time it took a signal to travel the length of the board, so the distribution and timing of the clock and data signals was critical.

To debug another board in the system one of my colleagues had persuaded management to lease a gigasample-per-second storage scope for a monthly sum about equivalent to his salary. I didn't fancy my chances of prying the money for a second scope out of my superior—indeed he suggested that I share the first one with my colleague on a twelve-hours-on, twelve-hours-off basis. Well, I knew who would get the night shift, so I rooted around in the company's calibration lab to see what I could find.

I dug up a Tektronix sampling scope that looked as if it hadn't been used in 25 years. Since I was apparently the only engineer in the company who knew what a sampling scope was, I was granted exclusive use of it, and I continued to work more or less normal hours. I made myself two 500-ohm probes with exactly equal time delays from a couple of lengths of 50-ohm coax and two 453-ohm resistors. With this equipment, I made all the timing measurements I needed and soon got my prototype board to work.

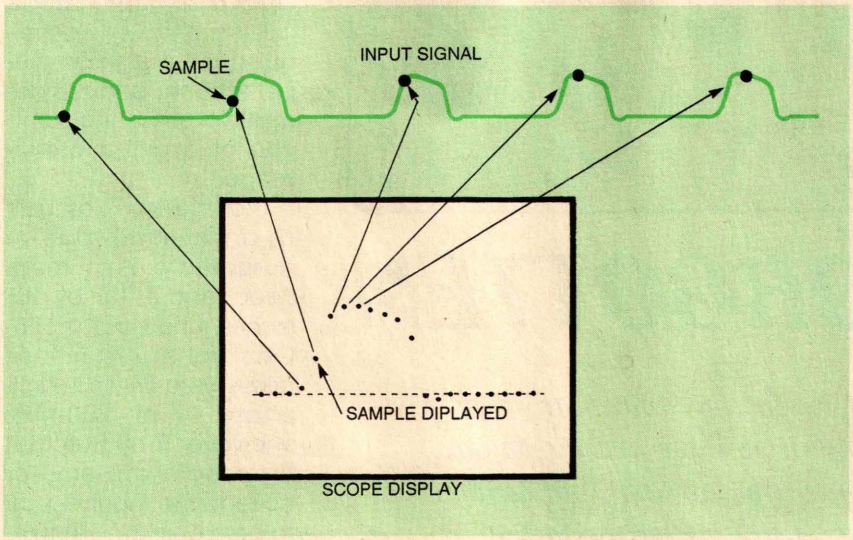


Fig. 1. Each dot on the display of a sampling scope represents the amplitude of a different input pulse at a particular instant. In practice many pulses may go by between each one that is sampled.

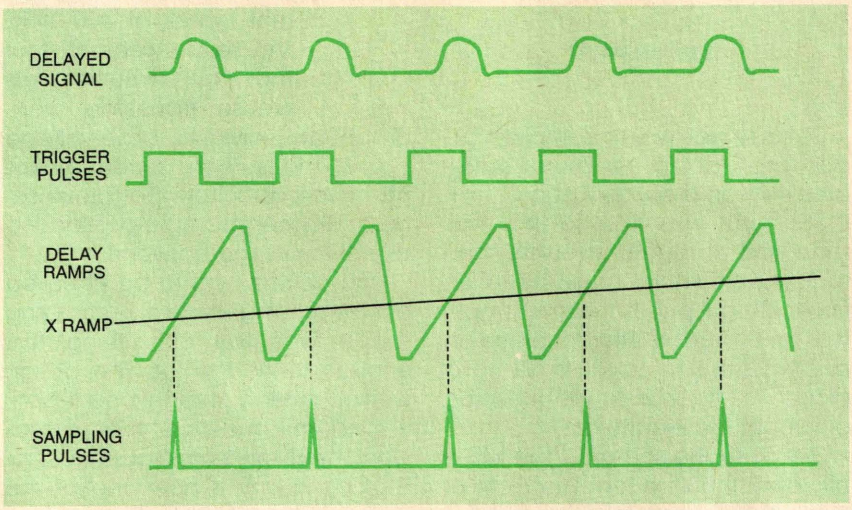


Fig. 2. A sampling pulse is generated when the ramp triggered by the undelayed input signal reaches the same voltage as the ramp that drives the X-sweep of the scope.

Is A Sampling Scope A Digital Scope? A digital oscilloscope uses one or more very fast analog-to-digital converters. Those take consecutive samples of the input signal and convert them into numbers. It stores from 1024 to a million or so of those numbers in memory, then stops. That is, a digital scope is ideal for recording events that happen just once. If you want to show a continuous signal you need to display and throw away the last set of samples, or save them in slower memory or on a disk, before you can take more.

A sampling scope doesn't digitize anything, and it can't work on a one-shot signal. It depends on the input signal repeating itself exactly, and it takes one sample from each of many input pulses. That means it has an appreciable time available to process each sample.

Each time around, the sample is taken from a slightly different place on the input waveform. The results are superimposed to build up a picture of a typical input pulse. Figure 1 shows how that works. The time resolution of the display equals the extra delay given to each sample time. For example, if pulses are sampled with delays of 1 through 50 ns, the display will show the first 50 ns of the pulse with a resolution of 1 ns. Of course, if the input signal is noisy or is not exactly repetitive, the output picture will be fuzzy.

Only the sampling and timing circuits need be fast; the processing circuit is slow and analog. That makes a sampling scope much simpler and cheaper than a digital scope. If you wanted to build your own digital scope, you'd first have to buy a fast ADC chip and a bunch of ECL memory chips. You're looking at a thousand dollars just for parts, not to mention the test gear and expertise you'd need to get it going. However, if you are familiar with ECL components and high-speed layout, it would be practical to build your own sampling front-end. That could extend the range

of an oscilloscope from, say, 50 MHz to 500 MHz. The output signal can be made slow enough to drive a chart recorder or even a computer's audio digitizer card.

How Does It Work? The secret of the sampling scope is that, even in the 1950s, some parts, particularly silicon diodes, were quite fast. If you applied a voltage ramp to a diode, a good device would go from nonconducting to conducting in under a nanosecond. Because of stored charge the diode might not turn off quite so fast, but it was still a lot faster than contemporary transistors. By switching one diode on and another one off almost simultaneously, you could make a switch that was only on for the few nanoseconds when both diodes were conducting.

Another important development was the ferrite material from which low-loss high-speed transformer cores could be molded. Fast pulses could be inverted using lengths of coaxial cable wrapped around ferrite rings, enabling four-diode switches to be driven in a push-pull fashion. The switching pulses had to be bigger than the signal, this reducing driver pulse feed-through.

Such a switch was connected between the input signal and a capacitor. The switch was terribly inefficient, but each time you drove the diodes you ended up with a capacitor voltage that was a function of the instantaneous input voltage at one particular moment in time.

That is a crude form of sample-and-hold circuit, and its output could be amplified with relatively slow components. Once the voltage was big enough to generate a useful deflection on a CRT, you had a dot on the display that was proportional to the input voltage sample. One input pulse produces one sample.

Now comes the clever bit. Assuming that the input signal is a repetitive pulse, you could trigger a ramp generator at the same point on each pulse. The ramp might last, say, 50 ns. After that time, you didn't worry about what happened so you could use slow components to reset it and be ready for the next cycle.

A second ramp generator was free-running and much slower; it might take 10 ms per cycle in a practical system. That ramp was subtracted from the fast ramp so that the time the sum took to reach some threshold voltage was delayed more and more the later you were on the slow ramp. With the fast comparators available today, you would apply the two ramps to the opposite inputs of a comparator, as shown in Fig. 2.

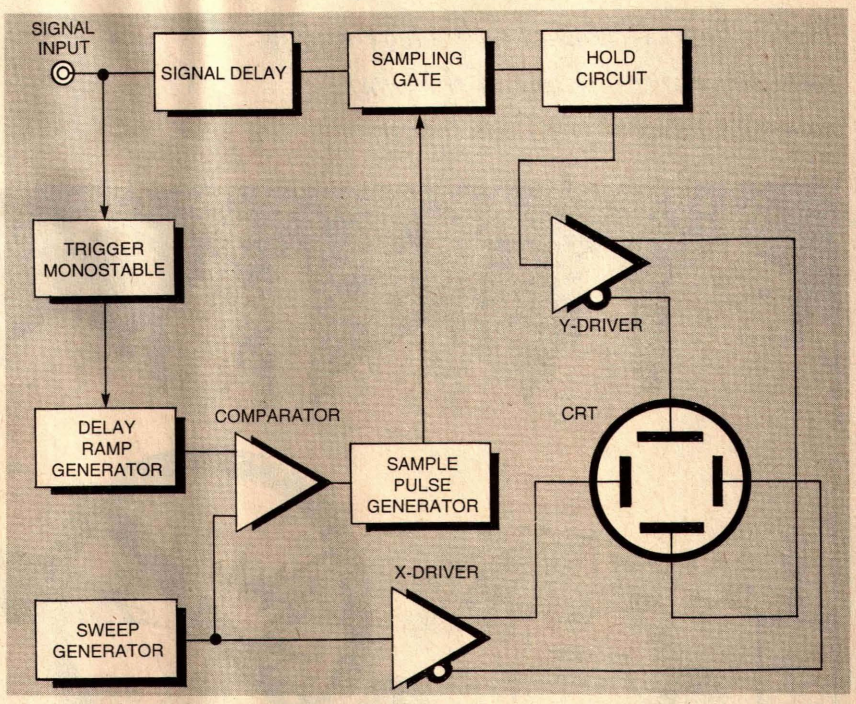


Fig. 3. Here's a block diagram of a sampling oscilloscope. Note that in a sampling scope, unlike a digital scope, only a few components have to operate at high speed.

Reaching the threshold triggered the sampling circuit; thus, each new sample was taken later and later in its respective input pulse. The X input to the CRT was driven from the slow ramp so the result was a picture of the input waveform that was redrawn every 10 ms. The X scale width was the time taken by each fast ramp, 50 ns in the example above. In that case, the effective time base sweep, 50 ns, was 200,000 times faster than the actual time base sweep, 10 ms.

Commercial sampling scopes had several inputs with matched timing characteristics, and they could be triggered from the input signal or from an external source. The latter was very useful for examining the characteristics of a filter or an amplifier, since the triggering input could come from the generator that was driving the device under test.

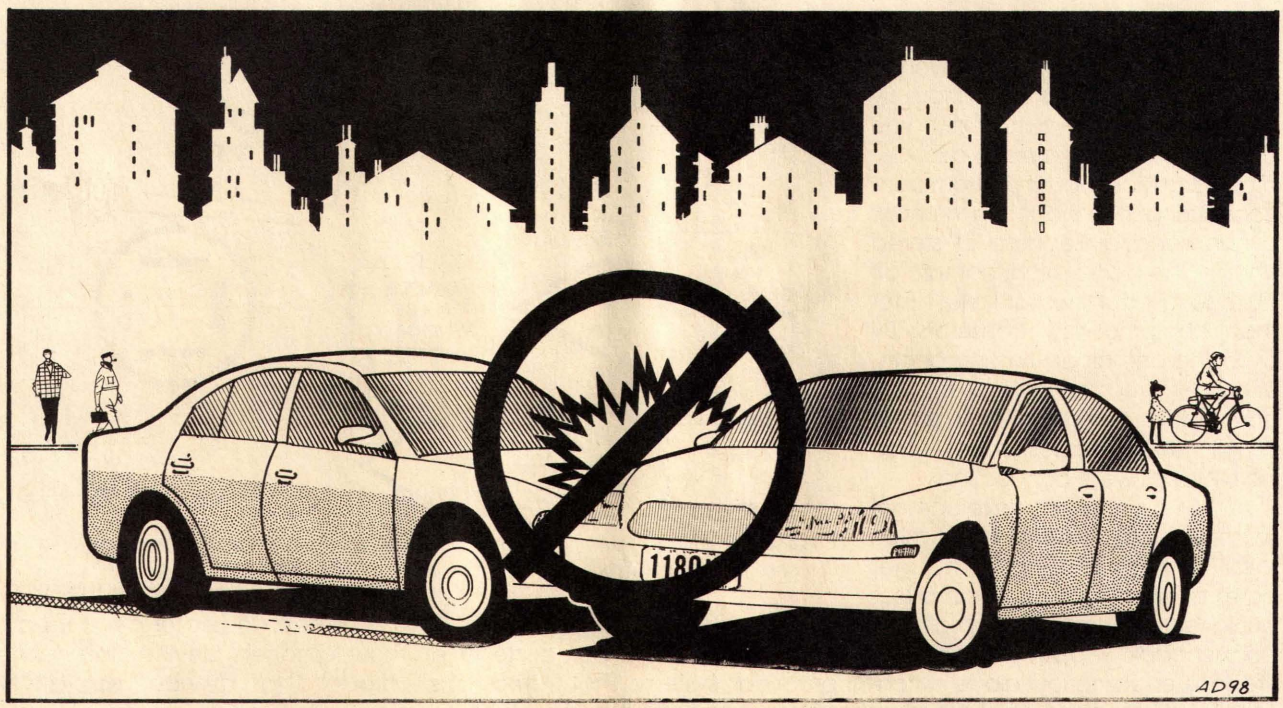
The test generator often used a now-forgotten device, the tunnel diode. That device had an N-shaped characteristic with a negative resistance region. As the current through the diode increased, the voltage across it would increase to perhaps 100 mV and then suddenly jump to 800 mV. The jump had a rise time as short as 100 ps.

With a tuned circuit and the correct bias current, a tunnel diode would oscillate at VHF frequencies. If you varied either the capacitor or the inductor, you got a micropower FM transmitter. One curious feature of the tunnel diode was that it was a majority-carrier, device, and its characteristics were almost independent of temperature. Transistors stop working if you make them too cold, but a tunnel-diode oscillator will carry on working even in liquid helium at 4 degrees absolute (K). I once used that feature to transmit measurements from inside a cryostat.

If you needed a bigger signal than the half-volt or so from a tunnel diode, you used an avalanche transistor. That is an ordinary transistor with a high-value collector resistor. With its base held at zero volts, the device could sustain some three times its normal breakdown voltage on its collector. When trig-

(Continued on page 60)

Here's how electronics technology might someday eliminate one of the most common types of traffic accident.



NO MORE ACCIDENTS

BILL SIURU

You're about to make a left turn across a busy intersection. Suddenly, an icon depicting a vehicle starts flashing on the Heads-Up Display (HUD) projected onto your windshield. By warning you that there isn't sufficient spacing between you and an on-coming vehicle, you possibly avoid a serious crash. That is just one of the capabilities of the Intersection Collision Avoidance (ICA) Threat Detection System being developed by the Calspan Corporation and Battelle Memorial Institute in a five-year long Intersection Collision Avoidance Using IVHS Countermeasures Program. The research is sponsored by the National Highway Traffic Safety Administration's (NHTSA) Office of Collision Avoidance Research.

According to the NHTSA, intersection collisions are second only to rear-end crashes in their frequency of occurrence. Collisions at intersections account for about a quarter of all police-reported crashes. This translates to 1.7 million crashes each year.

Initially, the researchers determined under what circumstances, and why, intersection crashes occur. Calspan researchers reconstructed over 200 intersection collisions. As shown in Table 1, they found a number of different causes for those collisions. They also were able to determine that those accidents generally could be classified as one of four types: violation of traffic-control devices (traffic light, stop sign, etc.), 43.9%; inadequate gap in crossing traffic, 30.2%; oncoming traffic left turn across path, 23.8%; and early entry into intersection, 2.1%.

Once the researchers had a better understanding of how and why intersection collisions happen, they were ready to develop countermeasures that could potentially reduce the number and severity of these collisions. While not all causes can be eliminated with advanced electronics technology, several of the major ones—faulty perception, driver inattention, impaired or obstructed vision, and violation of a traffic signal—could be addressed by countermeasure technologies. These are now being incorporated into an Intersection Collision Avoidance testbed vehicle, which is shown in Fig. 1.

Avoiding Accidents. According to the researchers, the optimum countermeasure method is to install intersection collision-avoidance equipment such as transponders on vehicles so they could actively interact with one another to avoid collisions. That would be somewhat like the Traffic Alert Collision-Avoidance System (TCAS) already used in aircraft. In that system, a TCAS-equipped

aircraft detects the presence of other aircraft fitted with TCAS transponders.

But because equipping every vehicle with interactive countermeasure equipment is unlikely, at least in the foreseeable future, vehicles would also have to rely on passive detection techniques. That could include front-mounted radar used with collision-avoidance algorithms. With those sophisticated mathematical algorithms, an on-board computer can determine if the vehicle is on a collision course with another vehicle.

The algorithms for the ICA Threat Detection System—developed by Calspan researchers—use information from several sources. Those include a vehicle front-mounted radar, the Differential Global Positioning System (DGPS), the Geographic Information System (GIS), an electronic compass, a radio communications system, and accelerometers.

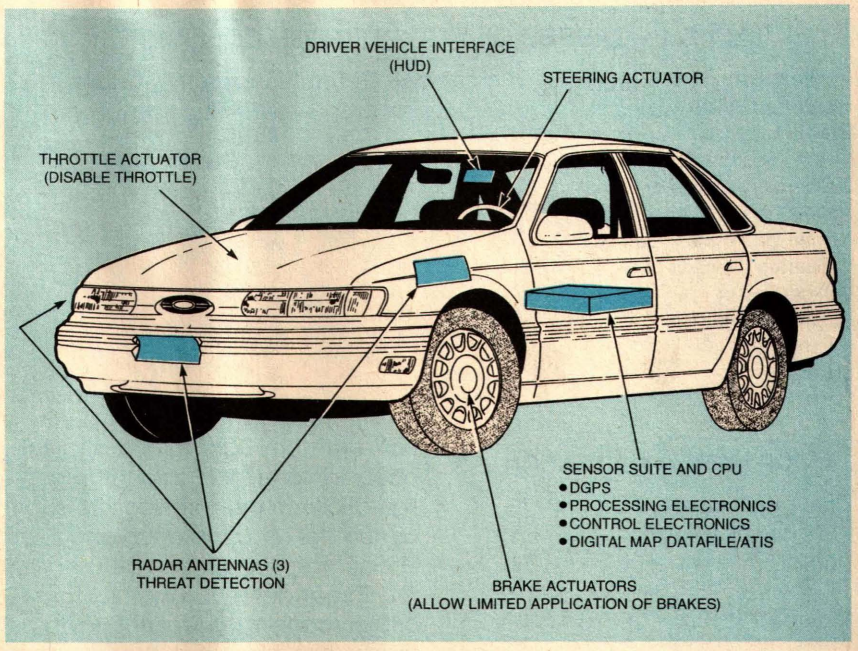


Fig. 1. This drawing of the ICA testbed vehicle shows the various on-board components of the system.

How it Works. A block diagram of the system is shown in Fig. 2. Two key ingredients of the Calspan Threat Detection System are DGPS and the GIS digital map database. DGPS and an electronic compass are used to precisely and continuously pinpoint the vehicle's current position and heading. DGPS—with an accuracy of about 3 feet, compared to about 300 feet for ordinary GPS,—provides the required level of precision for intersection-collision avoidance.

The GIS digital map database contains information about the intersection. That includes the road the vehicle is traveling on, the location of the particular intersection, and what traffic control devices (TCD) like traffic signals or stop signs are at the intersection. The current distance from the vehicle to the intersection is determined using

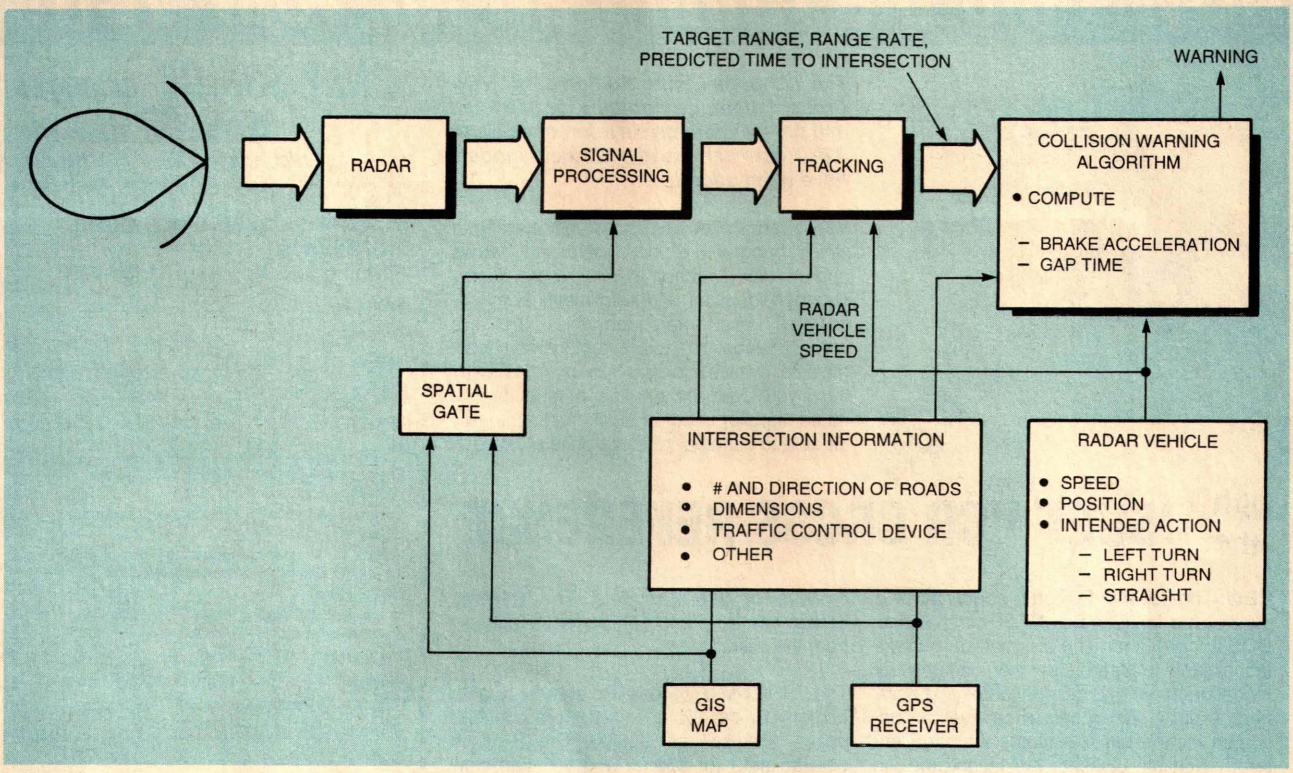


Fig. 2. A block diagram of the Calspan Threat Detection System. As is shown here, DGPS and the GIS digital map database play a large role in this passive collision-avoidance system.

TABLE 1—CAUSES OF INTERSECTION COLLISIONS

Reason	Percentage Of Total Intersection Crashes
Faulty Perception	33.88%
Driver Inattention	28.66%
Vision Impaired/Obstructed	11.13%
Deliberate Violation of Signal	9.01%
Attempt to Beat Other Vehicle	5.08%
Driving Under the Influence	4.57%
Deliberate Violation of Sign	3.38%
Vehicle Defect	2.09%
Attempt to Beat Traffic Control	0.90%
Hit and Run	0.31%
Other	0.99%

FOR MORE INFORMATION

Calspan Corporation
4455 Genesee Street
Buffalo, NY 14225
Tel: 716-632-7500; Fax: 716-631-6722
Web: www.calspan.com

position information from DGPS. The current status—red, green or yellow—of any traffic lights can be sent to the vehicle by the radio communication system.

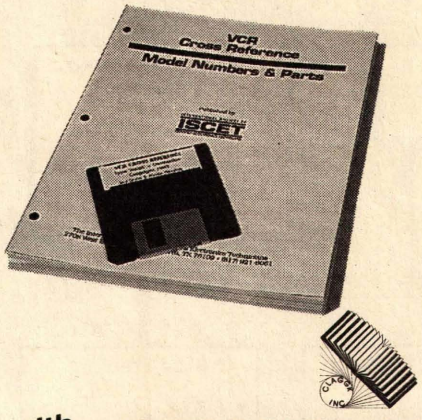
Sensors on the vehicle itself provide information on its speed and intended action at the intersection—left turn, right turn, or straight-ahead. Information about the configuration of the intersection, such as number and approach angles of intersecting streets, can be used by the threat-detection system to prioritize scanning directions towards areas that represent the greatest risk.

Information from all the sources is fed to an on-board computer, which determines if the vehicle is on a collision course with another vehicle or if the vehicle's travel rate indicates that it is about to run a red light or stop sign. If a dangerous situation exists, the Driver Warning System alerts the driver. This can include a flashing icon on the HUD. Icons that show the type of intersection hazard can include those depicting a traffic signal, direction of another approaching vehicle, or an insufficient gap in on-coming traffic to make a safe left turn across the intersection.

Another warning could be provided by automatically pulsing the brakes and disabling the throttle. Since driver inattention is a major contributing factor in intersection collisions, brake pulsing should usually be sufficient to get the driver's attention. Brake pulsing also slows the vehicle and is thus the proper vehicle response in this situation. If the driver fails to make the appropriate avoidance maneuver, the system could automatically take over and initiate full braking.

The next step is testing of the ICA testbed vehicle. The program will be completed in the fall of 1999. Then, hopefully, we will start seeing the technology appearing on new cars and trucks. Ω

NOW Find the Right Part for Your VCR!



The 172-page Eighth Edition of the VCR Cross Reference contains both model and part number cross references. Over 7,810 new parts and 1927 new models have been added.

VCR's are made in a few factories from which hundreds of different brand names and model numbers identify cosmetically-changed identical and near-identical manufactured units. Interchangeable parts are very common. An exact replacement part may be available only a few minutes away from you even though the original brand-name supplier is out of stock. Also, you may be able to cannibalize scrap units at no cost.

with the ISCET VCR CROSS REFERENCE

NEW! The Seventh Edition is contained on a 3½ diskette for IBM PC AT/XT compatibles, DOS 2.1 or higher. The disk software allows technicians to search by manufacturer for model numbers and description of part numbers. A parts editing sequence gives an on-screen view of all substitutes for parts entered. With the diskette, the technician can update files by adding model and parts crosses of future models. The Seventh Edition can be printed on pages completely from the diskette.

The ISCET VCR Cross Reference, Eighth Edition, is on 8½ × 11-in., pre-punched pages and sell for **$38.00**. The 3½ inch diskette sells for **$69.95** and you can view listings from a monitor or printed page.

ONLY $38.00 for pages
$69.95 diskette
Not including Shipping & Handling

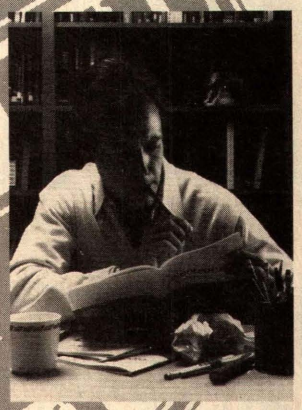
Claggk Inc.
VCR CROSS REFERENCE OFFER
P.O. Box 4099
Farmingdale, New York 11735-0793

Name _____
Business _____
Address _____
City _____
State _____ Zip _____
Phone _____

Enclosed **$38.00** for the ISCET VCR Cross Reference, Eighth Edition.
Enclosed **$69.95** for the Idiskette containing the ISCET VCR Cross Reference, Ver. 7.0
Include $4.00 for shipping Version 8 pages within the United States. All other countries add $5.00 (surface mail).
Include $3.00 for shipping Version 7 disk within the United States. All other countries add $4.00 (surface mail).
The total amount of my order is $ _____.
Check enclosed—do not send cash. US funds only.
☐ Visa ☐ MasterCard Exp. Date ___/___/___
Card No. _____
Signature _____
New York State residents must add applicable local sales tax to total. Overseas Orders use US bank check or International Money Order. CB02

1 Study at Home

We live in a constantly changing world, where exciting new technological advancements are made everyday. At the Cleveland Institute of Electronics we make it simple to train, earn a degree and prosper in the workforce. Over 150,000 students in the United States and 70 foreign countries got their start in electronics through CIE. And they received their education at their own pace in the comfort and convenience of their homes. At CIE you'll receive a first class education by a faculty and staff devoted to your career advancement. All of CIE course and degree programs are taught through a patented, proven learning process. To discover all the benefits and programs/ degrees available from CIE send for your free course catalog today.



CIE's Associate Degree program contains 397 lab experiments.

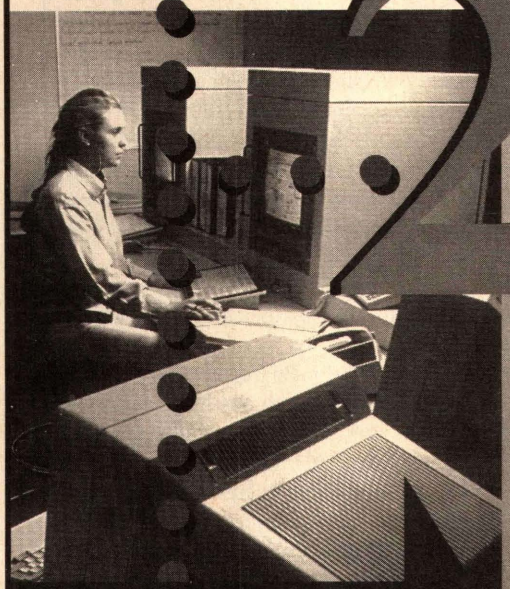
2 Work Where You Want

And once you complete your education at CIE, you can just about write your own ticket to where you want to work and in what specialized field... MIS, broadcasting, industrial, automotive, management... The opportunities seem limitless in today's high-tech world.

The Cleveland Institute of Electronics has been approved for use of Veterans Affairs Benefits and DANTES Tuition Reimbursement.

Tuition assistance from the Veterans Administration or the DANTES Program is available to veterans and service members in the Armed Forces.

Employees are seeking & hiring qualified applicants.



FREE CATALOG

CIE

1776 E. 17th Street
Cleveland, Ohio 44114-3679

Visit Our Web-Site
www.cie-wc.edu

☐ **YES!** I am interested. Please send me a catalog.

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone Number: _____

A school of thousands. A class of one. Since 1934. AE132

BY DON LANCASTER

Pseudoscience Today, Theater Lighting Controls, and more

IN MY OPINION, FINDING A SOURCE OF "UNLIMITED FREE ENERGY" WOULD BE ONE OF THE MOST HEINOUS POSSIBLE CRIMES AGAINST HUMANITY. THE UNAVOIDABLE CONSEQUENCES OF SUCH A DISCOVERY WOULD INCLUDE TURNING THE PLANET into a cinder.

Even so, great heaping piles of free energy enthusiasts can be located on the Web in such fantasy forums as Bill Beaty's odd www.eskimo.com/~bilb/freenrgl/fnrg or else Jerry Decker's www.escribe.com/science/keely Fortunately, almost all of free energy pseudoscience boils down to labwork so mesmerizingly awful that it is not even wrong. To me, it sure is challenging fun to find out exactly where and precisely how they have screwed up.

The outcome is never in doubt because accurately measuring real nonlinear power or doing small DT calorimetry can both be exceptionally difficult tasks. Worse, the results of those measurements will almost always be deceptively high when carelessly done. Everybody always fouls these up—at least on their first few hundred tries.

I've recently posted some essential tools that might let you intelligently evaluate pseudoscience on your own. Find those at www.tinaja.com/glib/bashpseu.pdf These key tools include finding out what is really happening, doing an objective meta study, using a binary consequence tree, slicing up with Ockham's razor, applying my highly devastating "looks like a duck, quacks like a duck" filters, avoiding negatives, and tracking the cash flow. Those tools separate useful adjuncts for porcine whole body cleanliness from the total hogwash.

Free Energy "Ludicrosities"

Here is my take on all the ongoing pseudoscience scam du jours:

The Adams Motor: To me, this one looks and acts exactly like a plain old switched reluctance motor. Except for having woefully inefficient flux paths, this is simply one continuously driven variant of the stepper motor. Independent tests give efficiencies in the 10 to 30 percent range. The extreme difficulty of measuring the rms power of pulse waveforms appears to be the basis for the overunity claims.

But: New "real" switched reluctance motors are poised to revolutionize air conditioning and electric autos.

Brown's Gas: A stoichiometric mix of two parts of hydrogen and one part of oxygen by volume provides many highly unexpected properties, none of which include proponent's claims of overunity, long-term monatomics, or radioactive neutralization. To date, zero believable differences between Brown's Gas and plain old stoke gas have ever been convincingly shown.

But: Rather exciting "real" hydrogen stuff is coming down over nanotube storage and metalloradicals.

The Neuman Motor: After a careful and long-term review, I do not see much here. Clear-cut and unarguable results seem conspicuously lacking. Recent web measurements on those large, high-voltage DC machines show efficiencies of 20 percent, but even these are suspiciously high, owing to a questionable power measurement. Uh, if a motor sparks, it is inefficient.

But: Exotic pulse energy recycling might improve battery life.

The Water-Powered Car: These seem to reside somewhere between wishful thinking and outright criminal fraud. "Molecular resonance" of water takes place at frequencies far higher than claimed and provides zero overunity options. If you don't believe that, ask any radio astronomer. There's very strong evidence that any strange waveforms or high voltages during electrolysis can only reduce your conversion efficiency. Another name for a system where a car engine drives some alternator that generates hydrogen that runs the engine is a dynamic brake. Switching it in would cause the auto to stop in much less than its usual coasting distance.

But: A modest hydrogen injection might improve the performance numbers of an otherwise stock gasoline engine.

The Magic Lamp: Take a 32-volt light bulb and a 110-volt bulb. Connect them to dimmers and adjust for equal

NEED HELP?

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher, AZ 85552
Tel: 520-428-4073

US e-mail: don@tinaja.com
Web page: http://www.tinaja.com

new from
DON LANCASTER

ACTIVE FILTER COOKBOOK
The sixteenth (!) printing of Don's bible on analog op-amp lowpass, bandpass, and highpass active filters. De-mystified instant designs. **$28.50**

RESEARCH INFOPACKS
Don's instant cash-and-carry flat rate consulting service. Ask any reasonable technical question for a detailed analysis and complete report. See www.tinaja.com/info01 for specifics. **$79.00**

CMOS AND TTL COOKBOOKS
Millions of copies in print worldwide. **THE** two books for digital integrated circuit fundamentals. About as hands-on as you can get. **$28.50** each.

INCREDIBLE SECRET MONEY MACHINE II
Updated 2nd edition of Don's classic on setting up your own technical or craft venture. **$18.50**

LANCASTER CLASSICS LIBRARY
Don's best early stuff at a bargain price. Includes the CMOS Cookbook, The TTL Cookbook, Active Filter Cookbook, PostScript video, Case Against Patents, Incredible Secret Money Machine II, and Hardware Hacker II reprints. **$119.50**

LOTS OF OTHER GOODIES

Tech Musings V or VI	$24.50
Ask the Guru I or II or III	$24.50
Hardware Hacker II, III or IV	$24.50
Micro Cookbook I	$19.50
PostScript Beginner Stuff	$29.50
PostScript Show and Tell	$29.50
PostScript Video & secrets	$29.50
PostScript Reference II	$34.50
PostScript Tutorial/Cookbook	$22.50
PostScript by Example	$32.50
Understanding PS Programming	$29.50
PostScript: A Visual Approach	$22.50
PostScript Program Design	$24.50
Thinking in PostScript	$22.50
LaserWriter Reference	$19.50
Type 1 Font Format	$16.50
Acrobat Reference	$24.50
Whole works (all PostScript)	$380.00
Technical Insider Secrets	**FREE**

BOOK-ON-DEMAND PUB KIT
Ongoing details on Book-on-demand publishing, a new method of producing books only when and as ordered. Reprints, sources, samples. **$39.50**

THE CASE AGAINST PATENTS
For most individuals, patents are virtually certain to result in a net loss of sanity, energy, time, and money. This reprint set shows you Don's tested and proven real-world alternatives. **28.50**

BLATANT OPPORTUNIST I
The reprints from all Don's Midnight Engineering columns. Includes a broad range of real world, proven coverage on small scale technical startup ventures. Stuff you can use right now. **$24.50**

RESOURCE BIN I
A complete collection of all Don's Nuts & Volts columns to date, including a new index and his master names and numbers list. **$24.50**

FREE SAMPLES
Check Don's Guru's Lair at *http://www.tinaja.com* for interactive catalogs and online samples of Don's unique products. Searchable reprints and reference resouces, too. Tech help, hot links to cool sites, consultants. email: *don@tinaja.com*
FREE US VOICE HELPLINE VISA/MC

SYNERGETICS
Box 809-EN
Thatcher, AZ 85552
(520) 428-4073

FREE catalog: http://www.tinaja.com

high brightness. Use a cheap enough meter, and you'll measure one third the current and one third the voltage on the 32-volt bulb and then jump to the wildly wrong conclusion that the 32-volt bulb is more efficient and uses less power (even though it is no cooler than the other bulb). Careful analysis quickly leads to classic E.E. student lab blunder #01-A—confusing average and rms on low duty-cycle waveforms.

But: A lot of high-efficiency lamps are now under study, but those are based on studiously avoiding any incandescence at all.

The Hydrosonic Pump: This is simply a blocked cavitating pump applied to generate heat. (Just what they warned me to avoid at all costs in fire school.) In other words, a high-wear pump with one-sixth the efficiency of a heat pump and six times the costs of a resistor, rerunning that classic "mechanical equivalent of heat" experiment and ignoring the fact that all mechanical energy is much "more valuable" than heat energy. This one comes out of the woodwork each decade.

But: A sonoluminescence is now associated with cavitation that leads to several really exciting new wonderments.

The Tesla Turbine: This involves bladeless discs that control shear forces in viscous liquids to convert moving fluid into rotary motion. Viscous liquids are inherently lossy, and thus demand a thermodynamic inefficiency. Your conversion clearly is a non-adiabatic process; one that always throws off unwanted heat. Thus, a Tesla turbine simply has to be inefficient to work at all.

But: When used backwards, Tesla turbines are quite useful for such essential tasks as pumping live fish or transporting frozen chickens.

The Switch Flippers: There are folks out there who claim that no current flows if you connect an open circuit wire to a battery. Instead, mysterious "superluminal" communications and an "etheretic energy transfer" takes place if you flip switches fast enough on long enough wires. Sorry, but a transient current always results the instant you connect any wire to any battery, open circuited or otherwise. The Maxwell field equations and the characteristic impedance of the line sets the initial current. The ultimate current is determined only after slower-than-light reflections from the load take place. This flipping concept is flat out wrong; too much of electronics simply would not work were it true.

But: There's all sorts of astounding real electronics uses for fast switch flips.

Homopolar Machines: The homopolar generator is the only known machine that can generate true DC. Because of special relativity, it turns out that it does not matter in the least whether the magnets move or not. There is no way to

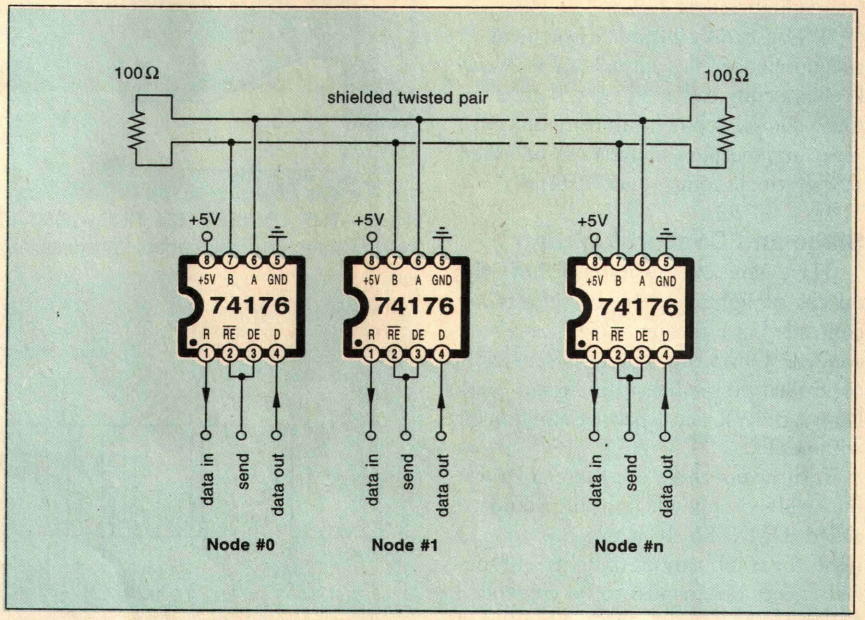


FIG. 1—THE RS485 SERIAL COMM STANDARD is widely used for computer networking. The older RS422 differs in that the left driver is permanently enabled, while all other nodes must act as receivers.

decide if a uniform magnetic field is rotating or stationary. Your homopolar output depends only on your relative stator and rotor speeds and the magnetic field strength. What the magnets are up to simply does not matter. Which can lead to severe misinterpretations and subtleties over what's really happening, especially in the way of counter EMFs and the reaction torques.

But: Homopolar machines are one possible solution to electric autos, as well as other "Uh compared to what?" needs.

Zero-Point Energy: If something is sitting still and you know where it is, you have got more information than when something is sitting still and you do not know where it is, which is what zero-point energy is all about. It's simply a way to get all the special relativity statistical math to balance out. Here's the kicker: If all of the gross zero-point energy in a volume the size of the earth were somehow 100 percent recovered, it would equal the chemical energy in one gallon of gasoline.

But: An exciting new field of Bose-Einstein Condensates is now opening up, revealing a previously unknown state of matter.

You'll find plenty of ongoing and lively Web discussions on all these topics. Start with www.dejanews.com to pick up as much detail as you can stand, both pro and con. On second thought, let's capitalize that: *Con*.

A wondrously bizarre assortment of pseudoscience files shows up at www.keelynet.com Links to others at www.tinaja.com/scweb01.html More objective "real engineering" analysis can be found at www.tinaja.com/pseudo01.html

Stage and Concert Lighting

Have you ever wondered how the dozens of lights and related effects are controlled at a theater, a club, or a rock concert? Obviously running a separately controlled power line to each and every lamp is ridiculously expensive and fraught with peril.

It turns out there is a fairly unknown but widely applied lighting standard called DMX512. It allows up to 512 lights (or combinations of lights and special effects commands) to be controlled by one cable.

Before we can look into DMX512, though, we'll first have to find out a little about...

EIA RS422/RS485

These are serial asynchronous data-communication standards. Note that RS422 has largely been replaced by the RS485, which we will mainly focus on here.

See Fig. 1. The key element in a RS485 circuit is a twisted pair transmission line. A digital logic one exists when "B" line of the pair is positive (between 2.5 and 5 volts) and the "A" line of the pair is near ground. A digital logic zero exists when the "B" line of the pair is near ground and the "A" line of the pair is positive (between 2.5 and 5 volts).

A driver circuit converts an input one or zero into the differential pair. A receiver circuit can sense that differential voltage and convert it on back to a local output one or zero. A transceiver is simply a chip that holds one or more receivers and one or more drivers. There can be dozens and sometimes hundreds of drivers and receivers in any combination, but only one driver can be active at one time. That can be handled by having a master driver that is in control of your system, or else by using some sort of collision detection.

Because of those balanced signals and the differential receivers, noise immunity can be quite good—all but incredibly bad common mode signals are ignored. Lines can sometimes be nearly a mile long.

Note that there must be one and only one terminating resistor at the "start" of the transmission line and one and only one terminating resistor at the "end" of the line. The line must go from device to device in the daisy chain manner shown in Fig. 1. Use of stubs or multiple paths is a no-no. Only one message can route over the RS422 or RS485 line pair at a time.

The RS485 standard is used for many computer-networking systems. When you use classic RS422 communications, only a single, permanently enabled driver is used. That driver chip must go at one end of the comm line, replacing the termination. A single RS422 line pair thus will be unidirectional only. It may have one transmitter driving any reasonable number of receivers.

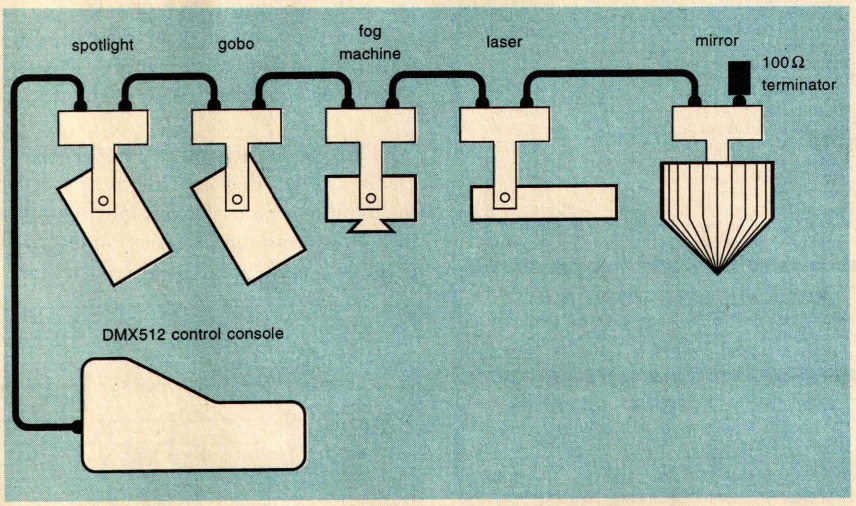


FIG. 2—THE DMX512 LIGHTING CONTROL STANDARD lets a single console and a daisy-chained wire pair control spotlights, fog machines, lasers, mirrors, or animation.

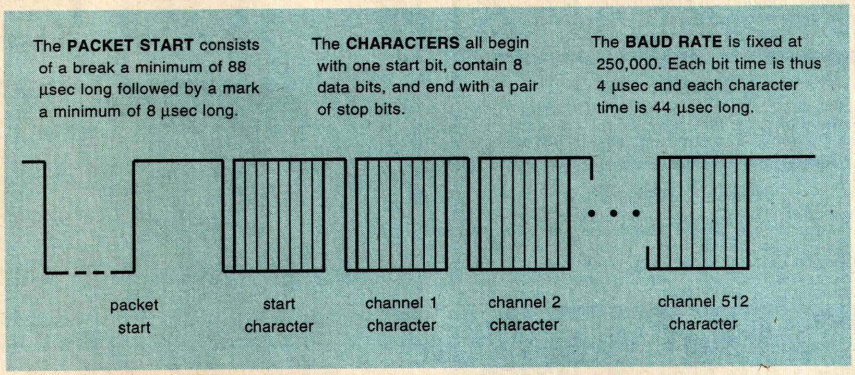


FIG. 3—DMX512 COMMUNICATIONS waveforms. Up to 512 8-bit channel commands can be sent to various devices along a chain up to 4000 feet long. Each device responds to its own channels in a selected proportional or on-off manner.

NAMES AND NUMBERS

Apex Microtechnology
5980 N Shannon Rd.
Tucson, AZ 85741
(520) 690-8600

Bumpon/3M
3M Center, Bldg. 220-7W-03
St. Paul, MN 55144
(800) 362-3550

Dallas Semiconductor
4401 Beltwood Pkwy. S
Dallas, TX 75244
(972) 371-4000

Electronic Expediters
14828 Calvert St.
Van Nuys, CA 91411
(818) 781-1910

International Journal of Hydrogen Energy
PO Box 248266
Coral Gables, FL 33124
(305) 284-4666

Lakeview Research
2209 Winnebago St.
Madison, WI 53704
(608) 241-5824

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035
(408) 432-1900

Loctite
1001 Trout Brook Cross
Rocky Hill, CT 06067
(860) 571-5100

Micrel Semiconductor
1849 Fortune Drive
San Jose, CA 95131
(408) 944-0800

Pacific NW National Laboratory
Box 999
Richland, WA 99352
(509) 372-4270

Synergetics
Box 809
Thatcher, AZ 85552
(520) 428-4073

Texas Instruments
PO Box 809066
Dallas, TX 75380
(800) 336-5236

Peter Zelchenko
1757 W Augusta Blvd. #3
Chicago, IL 60622
(312) 733-2473

Additional details are in the EIA standards themselves or in a great tutorial found at www.bb-elec.com/bb-elec/literature/485appnote.pdf

The latest replacement for either standard is RS644, which is called low voltage differential signaling. New chips here are the 65LVDS31 driver and a 65LVDS32 receiver from the folks at Texas Instruments.

DMX512

A theater lighting-control system using the DMX512 standard is shown in Fig. 2. It uses an RS422 or newer standard twisted pair to get from a control console up to whatever lights and devices need to be controlled.

The serial code is shown in Fig. 3. Its packet consists of a header and up to 512 data blocks. Each data block is called a channel and holds an eight-bit word. These words might be sensed as eight individual on-off controls, might set a brightness to one of 256 levels, or might be set to a linearized but lesser number of levels. Channels could be paired for 16-bit resolution. Several channels might be used for one device: perhaps one to set your level, one to set the color, and two to set the position. Non-lighting effects such as smoke generators, spinning mirrors, animation, and certain laser effects could also be controlled.

Your baud rate is 250,000 bits-per-second. When the full 512 words are used, updates take place at a maximum rate of around 44 per second.

Each channel byte uses one start bit, eight data bits, and two stop bits similar to classic UART serial communications. Those 11 bits make each channel byte 44 microseconds long.

The packet starts with a logic zero that is at least 88 microseconds long. That is followed by a MAB, or *M*ake *A*fter *B*reak that is 8 microseconds or longer. A start character follows that and forms an optional enable.

Up to 512 bytes of channel data follow. Each byte can represent any 8-bit value from 0 to 255. The use of these values depends on the device being addressed. Each device is set to respond only to its intended channels.

Suitable shielded twisted-pair cables include Belden 9841 and 9842, and Alpha 5274. Normal terminating resistance is 110 ohms.

The system uses 5 pin XLR connectors, with male connectors on the cables or terminators and female on the devices.

Concert Lighting: Techniques, Art & Business, James Moody, *Focal Press*, 1997.

Concert Sound and Lighting Systems, John Vasey, *Butterworth-Heinemann*, 1994

Control Systems for Live Entertainment, John Huntington, *Butterworth-Heinemann*, 1994.

Discovering Stage Lighting, Francis Reid, *Focal Press*, 1993.

Effects for the Theatre, Graham Walne, Drama Publishers, 1995.

Handbook of Scenery, Properties and Lighting, Harvey Sweet, *Allyn & Bacon*, 1995.

Light on the Subject: Stage Lighting for Directors, David Hays, *Limelight Editions*, 1989.

Lighting and Sound (Phaidon Theater Manual), Neil Fraser, *Phaidon Press*, 1995.

Lighting and the Design Idea, Linda Essig, *Hbj College & School Div*, 1996

Lighting the Stage: A Designer's Experiences, Francis Reid *Focal Press*, July 1995

Painting with Light, John Alton, *University of California Press*, April 1995.

Projection for Performing Arts, Graham Walne, *Focal Press*, 1995.

Recommended Practice for DMX512, Adam Benette, *USITT*, 1993.

Scene Design and Stage Lighting, Oren Parker, *Holt, Reinhart & Winston*, 1996

Stage Lighting Design: The Art, Craft, & Life, Richard Pilbrow, *Drama Publishers*, 1997.

Stage Lighting Handbook, Francis Reid, *A & C Black*, 1996.

Stage Lighting in the Boondocks, James Miller, *Meriwether Publishing*, 1987.

Stage Lighting Revealed: Design & Execution, G. Cunningham, *Betterway Pubs*, 1993.

Stage Lighting Step by Step, Graham Walters, *Betterway Publications*, 1997.

Theater Backstage from A to Z, Warren Lounsbury, *University of Washington Press*, 1989.

Theater Lighting from A to Z, Norman Boulanger, *University of Washington Press*, 1992.

Theater Technology, George Izenour, *Yale University Press*, 1997.

FIG. 4—SELECTED THEATER and concert lighting books. More details on many of these titles are found at www.tinaja.com/amlink01.html

The pinouts for the connectors are: pin 1—shield and common; pin 2—dimmer complement; pin 3—dimmer true; pin 4—optional complement; and pin 5—optional true.

DMX RESOURCES

AMX
11995 Forestgate Dr.
Dallas, TX 75243
(800) 222-0193

Angstrom
837 N Cahuenga Blvd.
Hollywood, CA 90038
(800) 422-5744

Artistic License
Livingstone Ct., Peel Rd.
Harrow, Middlesex HA37QT
England

Electronic Theater Controls
630 9th Ave., Ste. 1001
New York, NY 10036
(212) 397-8080

ESTA
875 Sixty Ave., Ste. 2302
New York, NY 10001
(212) 244-1505

Doug Fleenor Design
396 Corbett Canyon Rd.
Arroyo Grande, CA 93420
(805) 481-9599

International Laser Display Assn.
4301 32nd St. W, Ste. B-23
Bradenton, FL 34205
(941) 758-6881

Mole-Richardson
937 N Sycamore Ave.
Hollywood, CA 90038
(323) 851-0111

PLASA
38 Leonards
Eastbourne, E Sussex BN21 3UH
UK

Production Arts Lighting
636 Eleventh Ave.
New York, NY 10036
(212) 489-0312

Pyrotechnics Guild International
Bill Sprague
93 Poquanticut Ave.
N Easton, MA 02356

USITT
6443 Ridings Rd.
Syracuse, NY 13206
(800) 93USITT

Note that there is zero error correction here and that the optional return channel has nonstandard uses. Thus, DMX512 should definitely not be used for pyrotechnics or anywhere public safety is a concern.

Although a variety of commercial controllers are readily available, you can easily build your own DMX512 controller as a mid-range PIC project. Additional PIC support appears at my www.tinaja.com/picup01.html

I've gathered a few of the DMX512 standards, suppliers, and info sources together in the resource sidebar. A useful site is www.dmx512.com An amazing number of nice international-lighting links appear at www.ozemail.com.au/~bhill/links.html

Apparently the "must have" book is Adam Bennette's *Recommended Practice for DMX512*. It and the standard itself can be obtained from USITT, short for the US Institute of Theater Technology. Useful newsgroups include: alt.stagecraft, comp.arch.embedded, net.theatre.stagecraft, rec.arts.theater.stagecraft, and sci.engr. lighting

My choices of popular and more general books on concert and theater lighting are shown in Fig. 4. More details on many of these titles are at www.tinaja.com/amlink01.html

New Tech Lit

From Apex comes their new data book on power integrated circuits. And from Micrel, there's a data booklet on their new QwikRadio single-chip UHF modem data receivers. Only three external parts are needed here!

A new free data book and CD ROM is available from Dallas Semiconductor. Dallas seems to be the first one to tame the data monster by providing only the first page of each data sheet in the printed catalog. You go to the CD or their site at www.dalsemi.com when you need more detail.

Free Filter Design Software for Windows CD is now being promoted by Linear Technology.

Electronic Expediters has some 33 million integrated circuits and semis in stock. Check www.expediters.com But a much better source for instant ordering of single quantity samples is www.questlink.com

Serial Port Complete is a new Jan Axelson book on RS232 and RS484 links and networks. PCs, Basic Stamps, and other popular micros are well covered. A companion software disk is included. Jan also wrote the great *Parallel Port Complete* text. The publisher is Lakeview Research More at www.tinaja.com/amlink01.html

Volume One: The Instant Book is a bound tutorial by Peter Zelchenko on Book-on-demand publishing. Contact him at www.volumeone.net For more on BOD, other service bureaus, and related topics, check the details at www.tinaja.com/bod01.html

The latest release of the *Inventor Assistance Source Directory* is newly available from the Fed's Inventions & Innovation program. The publisher is Pacific Northwest National Lab. But remember that calling yourself an "inventor" is often monumentally stupid. Find out why at www.tinaja.com/patnt01.html

The superb *International Journal of Hydrogen Energy* is one definitive but extremely expensive ($1476) publication. Chances are you could access copies through a larger library. Additional magazines on hydrogen, books, links, and resources are found through my www.tinaja.com/h2gas01.html

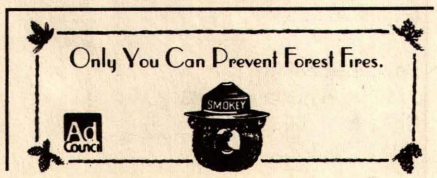
Free samples of new light-curing adhesives are available through Loctite. They also publish a new product selector guide. Free samples of Bumpon stick-on feet are available from 3M.

For those fundamentals of active-filter design, check my *Active Filter Cookbook*. Available by itself or in my *Lancaster Classics Library*. See my nearby Synergetics ad or visit my www.tinaja.com/synlib01

I've finally managed to provide a powerful online site search for my www.tinaja.com Web site. Yeah, this now includes full text searching for all the tutorial Acrobat PDF files. As well as the usual HTML and text. A bunch of earlier columns have newly been uploaded.

Instant answers and cost-effective technical solutions can be found at www.tinaja.com/info01.html, while lots of great test equipment bargains (especially superb Tek 2213 scopes and fantastic buys on premium logic data analyzers) are found by clicking www.tinaja.com/barg01.html

As usual, most of the mentioned items are in our "Names and Numbers" or "DMX Resources" sidebars. Always look here first before calling our free US technical helpline. EN

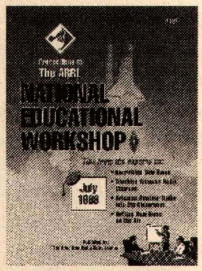


NEW LITERATURE

continued from page 30

Proceedings of The ARRL National Educational Workshop

The American Radio Relay League
224 Main Street
Newington, CT 06111
Tel: 800-243-7767
Fax: 860-594-0303
e-mail: jwolfgang@arrl.org
Web: www.arrl.com
$12



CIRCLE 341 ON FREE INFORMATION CARD

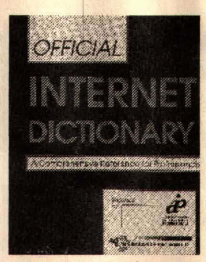
Designed for educators who teach amateur radio and written by experts in the field, the articles in this volume discuss such subjects as getting new hams on the air, recruiting hams, teaching amateur-radio courses, and bringing amateur radio into the regular classroom.

There are case studies of programs in schools around the country, stories of teaching radio for scout badges, and discussions of integrating science and ham radio. Other topics include ham radio and the Internet, Morse Code, technical careers, youth clubs, books on ham radio, and teaching amateur radio to people with disabilities. In the over 40 articles in these proceedings, there is something of interest for educators, hobbyists, and anyone who wants to encourage the growth of ham radio enthusiasts.

Official Internet Dictionary: A Comprehensive Reference for Professionals

Edited by Russ Bahorsky
Government Institutes
4 Research Place, Suite 200
Rockville, MD 20850
Tel: 301-921-2355
Fax: 301-921-0373
Web: www.govinst.com
$49 plus $6 S & H in U.S.

While there is no shortage of information available on the Internet, managing that information is becoming overwhelming. This new reference book provides advanced, professional, and new Internet users with an authoritative and



CIRCLE 342 ON FREE INFORMATION CARD

practical source of information on the World Wide Web, electronic mailing lists, e-mail, and a wide variety of other Internet resources. Endorsed by the Association of Internet Professionals and the Webmaster's Guild, the dictionary defines the language of the Internet and its most important functions for marketers, network administrators, programmers, and other professionals.

In addition to providing a thorough glossary of terms pertaining to networking, Internet programming basics, electronic commerce, Internet applications from web browsers to mail-user agents, and the issues shaping the future of the Internet, the dictionary also includes several essential resources for Internet users. They include a file name extension finder, guide to advanced search tools, command guides to the most widely used electronic-mailing-list programs, a quick- reference index of the language of Internet shorthand, and an error-message analysis chart for effective troubleshooting.

Guide To Emergency Survival Communications: How To Build and Power Your System

by Dave Ingram
Universal Electronics, Inc.
4555 Groves Road, Suite 12
Columbus, OH 43232-4135
Tel: 614-866-4605
Fax: 614-866-1201
$20

CIRCLE 343 ON FREE INFORMATION CARD

This is the first complete, up-to-date book dealing with survival communications—the ability to receive accurate and timely information in time of crisis. Covering the subject in depth, this guide discusses the many types of communication systems that are available and where they can be found: shortwave, amateur radio, citizen's band, federal services, weather services, overseas news services, plus many more important sources of vital information and programming.

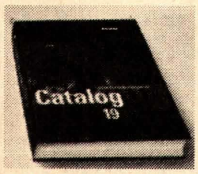
Ways of finding and choosing the proper equipment and building a communication system are discussed in detail. Using simple radio equipment to keep in touch with friends, without needing to take a radio license test of any sort, is explained

Information is provided to help readers build and set up systems using various types of emergency power sources, including inexpensive solar-power systems, small generator systems, and back-up emergency battery systems that start to work when the power grid goes down. This guide also covers building inexpensive satellite radio systems that can be powered by alternate power sources, such as solar and wind power.

BooksNow To order books in this magazine or, any book in print. Please call anytime day or night: **(800) BOOKS-NOW (266-5766)** or (801) 261-1187 ask for ext. 1454 or visit on the web at **http://www.BooksNow.com/electronicsnow.htm.**
Free catalogs are *not* available.

1998 Test & Measurement Catalog

Hewlett-Packard Company
Test & Measurement Organization
P.O. Box 50637
Palo Alto, CA 94303-9512
Tel: 800-452-4844, ext.5766
Web: www.hp.com/go/tmc98
Free



CIRCLE 344 ON FREE INFORMATION CARD

This 640-page hard-cover catalog includes descriptions of more than 1400 Hewlett-Packard test and measurement products, systems, and services. It provides a convenient resource for researching, planning, budgeting, and purchasing a broad range of test products and services.

Featured in this catalog is the HP Infinium digital oscilloscope, a state-of-the-art digital instrument with the look and feel of an analog scope. It offers a Windows-95 based GUI and built-in measurement assistance and set-up guide. These capabilities help users make complex measurements easily and quickly.

Many other advances in measurement and test technology are contained in this edition. Among the new products included are the HP E2310A Logic Dart Advanced Logic Probe, the HP Advanced Design System, the HP 81200 330/660

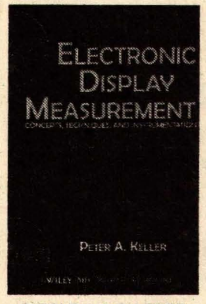
MHz Data Generator/Analyzer, the HP E8400A VXI Mainframe and low-cost, plug-in modules, and the HP AccuSite CDMA PCS base-station test set.

Along with descriptions and technical specifications of standard products and systems, the catalog also includes product-comparison charts, tutorial material, an indexed list of application notes, and descriptions of other available literature such as newsletters and specialty catalogs.

Extensive bibliographies are provided for the readers who wish to delve more deeply into any topic. Equations in the body of the text are kept to a minimum, but a full set is provided in an appendix. Other appendices contain the CIE Standard Observer tables and provide information on international and national standards organizations, national standards laboratories, equipment suppliers, and calibration services. EN

Electronic Display Measurement: Concepts, Techniques, and Instrumentation

by Peter A. Keller
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158
Tel: 800-225-5945
Web: www.wiley.com
$69.95



CIRCLE 345 ON FREE INFORMATION CARD

Written in a conversational style, this volume is the first complete reference manual in its field. A practical and up-to-date guide to the most reliable techniques, methods and instruments available for measuring electronic displays, it is an invaluable tool for designers, engineers, and manufacturers of display systems.

This book describes practical techniques and instrumentation used for display measurement and the common pitfalls that result in errors. The author presents each major topic from a basic to a working level in a self-contained chapter so that all the relevant information is easily accessible without cross-referencing. This easy-to-understand manual helps readers gauge the dependability, accuracy, and competitiveness of any electronic display. It explains how to measure luminance, resolution, contrast, quality, color, uniformity, registration, and more.

BooksNow To order books in this magazine or, any book in print. Please call anytime day or night: **(800) BOOKS-NOW (266-5766)** or (801) 261-1187 ask for ext. 1454 or visit on the web at **http://www.BooksNow.com/electronicsnow.htm.**
Free catalogs are *not* available.

FAST BUT FORGOTTEN

(continued from page 47)

base, many transistors, even quite slow ones, will turn on in a nanosecond, generating a negative going edge perhaps 30 volts high.

If you connected a delay line to the collector, you could generate 5 ns pulses that no other contemporary device could match. Early sampling scopes used avalanche transistors to generate the short pulses that turned on their sampling diodes.

Practical sampling scopes had built-in signal delay lines. It takes a finite time to trigger the fast ramp. Without a signal delay, the front edge of a pulse would always be out of sight whenever internal triggering was used. That delay line was often made from rigid coax that zigzagged down the inside of one side of the scope. The cheaper sampling scopes had effective rise times in the half-nanosecond region, but some worked down to some tens of picoseconds and allowed you to examine microwave signals.

The sampling scope had its disadvantages. Its behavior was critically dependent on the repetition rate of the input signal. If it was too slow, then so was the update rate of the display and it would flicker. If it was too fast, then the trigger circuit had to ignore most of the input pulses. It often took some skill to come up with a stable display.

Figure 3 shows the block diagram of a sampling scope. The input has a 50-ohm impedance, so unless the circuit under test is designed to drive 50 ohms, you need attenuating probes to avoid loading the circuit. Typically the input can handle signals within the range +1 to -1 volts. The trigger circuit is connected directly to the input but hardly loads it at all; the real input load is the signal delay line. The sampling unit and a 50-ohm termination resistor are connected to the end of this cable. The sampler is a simple diode bridge that is turned on and off again by a very short pulse. It is transformer-coupled to the diodes, which are hot-carrier diodes that turn on and off with minimal delay. Once the input is sampled, the result is stored in a capacitor. That drives a conventional sample-and-hold circuit that retains each input sample as long as it is needed for the display.

Each time it is triggered, the ramp circuit generates a pulse with a sloping front edge. This slope is adjustable and acts as the time base for the sampler. That is, a 50 ns slope results in a display whose width corresponds to 50 ns at the input. The length of the pulse can be adjusted to set the time between sampled inputs to a convenient value.

That pulse drives one input of a comparator. The other input is driven by the slow ramp, which forms the X input to the display. When the two ramps are equal, the comparator fires the sampling pulse to measure the input amplitude. This drives the Y input to the display and makes a dot on the screen. The successive dots outline the shape of the input signal.

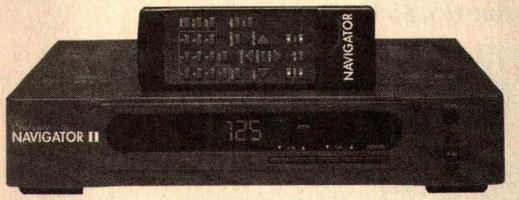
Building Your Own Scope. Designing and building conventional oscilloscopes was something of a hobby of mine when I was a physics student. By the time I was professionally involved in electronics, analog scopes had reached the 300-MHz bandwidth of the early sampling scopes and the latter were relegated to specialist uses.

From time to time, I contemplated building my own sampling scope. Recently I took another stab at it. After breadboarding the timing circuit I concluded that, although it was a feasible project, I could not justify further effort. High-speed electronics is pretty tricky and success depends on many tiny details. While I didn't doubt that I could get something running, I thought I was unlikely to end up with a design that the average home-brewer could put together. However, constructing a sampling scope could be an interesting project for the advanced amateur. Ω

SUPPLEMENT TO ELECTRONICS NOW NOVEMBER 1998

Electronic SHOPPER®

THE Ultimate Navigator Series



- Advanced Baseband Replacement
- Interactive On Screen Display
- Remote Control
- 125 Channel Capacity
- Watch One Premium While Recording Another
- Parental Control *with timed lock / unlock schedules*
- Watch and Record Capability
- Easy Read Clock
- Preloaded Channel Labels
- Unique Favorite Channel Theme System
- Audio/Video Input and Output
- Addressable/Programmable
- Electronic Program Guide Available*

* *Also exclusively available* STARSIGHT ELECTRONIC PROGRAM GUIDE THE NAVIGATOR SERIES

- One Touch Recording
- Eliminates Complicated VCR Programming
- Current, Future or Series Recording
- Categorizes All Programming
- Displays Time, Date, Rating, Starring Actors, and More
- Seven Day Programming
- Free 90 Day Subscription

ElitePremier

New!

Stargate Infinity 3000A

SHARP'S™ NEW PREMIUM DYNAMIC TUNER

- NO OTHER CABLE BOX GIVES A SHARPER PICTURE

FEATURES OF ELITE PREMIER

- Volume Control
- Audio/Video Out
- Slim Line Remote
- 800 MHz / 125 Channel
- Parental Control
- Unlimited Favorite Channel
- STD/HRC/IRC Switchable
- Automatic Fine Tuning

Elite 800

- Slim Line Remote
- 800 MHz /125 Channel
- Parental Control
- Unlimited Favorite Channels
- STD/HRC/IRC Switchable
- Manual Fine Tuning
- Manual Tune Override

Prices Too Low to Print!

- Upgradeable Micro Card
- 125 Channel / 800 MHz
- Volume Control
- Audio/Video Outputs
- Sleep Timer
- Parental Control
- Dynamic Memory Recall
- Automatic Low Signal Enhancer
- Last Channel Recall
- Unlimited Favorite Channels
- Slim Line Remote
- Automatic Fine Tuning

VIEWER'S CHOICE ELECTRONICS

5337 SOUTH CAMPBELL AVENUE, SUITE A2, SPRINGFIELD MO 65810

800-228-7404 FAX 417-887-2883

www. viewerchoice.com

CIRCLE 259 ON FREE INFORMATION CARD

Network Service Tool Set

Popular installation and service tools for networks, modems and telephones. All hand tools are professional heavy duty type.

Use the compact tester on 10BASE-T (UTP & STP), thin Ethernet (BNC), 8-position Token Ring, AT&T 258A and EIA/TIA 568A/B. Automatically scans cables for continuity, wiring sequence and polarization. Tests STP cable ground. Testing installed cables is easy with Remote Terminator and gender changers (UTP and BNC). 9V battery included.

- Coax Stripping Tool, RG-58 & RG-59
- BNC Crimping Tool, RG-58 & RG-59
- Modular Cutting/Stripping/Crimping Tool (4, 6 & 8-Position)
- Multi-Network Cable Tester
- AC Receptacle Tester
- Cable Cutter

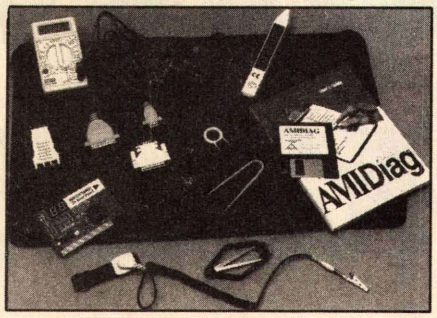
Order No. 55625 $197.00

PC Service Tool Set

Contains all tools needed to troubleshoot & service IBM-compatible PCs. Set includes:

- AMI Diagnostic Software
- POST Card
- Logic Probe
- Digital Multi-Meter
- AC Receptacle Tester
- Serial Adapter
- Serial & Parallel Loopback Connectors
- DIP IC Puller
- PLCC IC Puller
- Grounding Wrist Strap
- Key Top Puller

Order No. 55000 $198.00



PC Diagnostic Tool Set

- AMI Diagnostic Software
- POST Card

Order No. 55555 $89.00

Network Installation Tool Set

- Network Tool Set 55625 without the Multi-Network Cable Tester.

Order No. 55600 $99.00

Call for your FREE Catalog

Graymark®

P.O. Box 2015 Tustin, CA 92781
http://www.labvolt.com

CALL TODAY!

800-854-7393

VISA MasterCard AMERICAN EXPRESS Cards DISCOVER NOVUS

CIRCLE 329 ON FREE INFORMATION CARD

ALFA ELECTRONICS

HIGH QUALITY TEST EQUIPMENT

Visit www.alfaelectronics.com for complete info

Call 1-800-526-2532 for Order and Free Catalog

DMM

DMM-89S ($179.00): true rms, AC/DC (V,A), Ω, bar graph, freq, capac., dBm, logic, diode
DMM-23T ($99.95): 4½ digit, true rms, high resol. (10μV, 10nA, 10mΩ), hFE, diode, contin.
DMM-20 ($74.95): AC/DC (V, A), Freq, cont., Capac, Induct., Ω, hFE, diode, duty cycle
DMM-122 ($59.95): DC/AC(V,A), Ω, hFE, diode, capacitance, freq, logic, continuity
DMM-123 ($44.95): DMM + capacitance, DC/AC(V,A), Ω, hFE, diode, continuity
DMM-10 ($19.95): 3½ digit, DC/AC V, Ω, hFE, diode, signal output(+3V,-0.5Vsq.,50%duty)

LCR /COUNTER

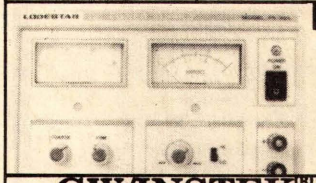
CAP-15 *($49.95)*: 3½ digit, 0.1pF-20mF, 9 Ranges, 0.1pF resolution, zero adjustment.
LCR-24 *($119.95)*: 0.1μH-200H, 0.1pF-2000μF, 0.01Ω-20MΩ, diode test. *New Model.*
LCR-131D *($219.95)*: autorange, 0.1μH-10kH, 0.1pF-10mF, ImΩ-10MΩ, Q Factor, serial/parallel, 120Hz/1kHz testing mode.
FC-1200 *($129.95)*: 1.25GHz Handheld, 8 digits display, 10ppm accurary, sensitivity 5mV (130-350MHz), 30mV (440MHz)

FLUKE

12B	$ 94.95
70-III	$ 99.00
73-III	$125.00
75-III	$155.00
77-III	$173.00
79-III	$195.00
87-III	$325.00
92B-III	$1,445
96B-II	$1,695
99B-III	$2,095
105B	$2,495
123-III	$1,130
863E	$555
867B	$740

SPECIALTY

• AC Current Probe	$34.95
• DC/AC Current Probe	$79.95
• Mini AC Clamp	$59.95
• AC Clamp w/temp	$89.95
• DC/AC Clamp	$109.95
• Thermometer	$69.95-$89.95
• IR Thermometer	$189.95
• Sound Level Meter	$169.95
• Tachometer	$169.95-$219.95
• EMF Tester	$69.95
• Pressure Meter	$299.95
• Watt Meter	$129.95
• High Voltgae Probe	$59.95
• pH Meter	$79.95
• Light Meter	$79.95-$89.95



Single Output DC Power Supplies

- Constant current, constant voltage mode
- Short Circuit and overload protected

Analog Meters Display
PS-303 ($159.00) 30V/3A
PS-305 ($219.95) 30V/5A
PS-8112 ($399.95) 60V/5A
PS-1610 ($289.00) 16V/10A
PS-8107 ($399.95) 30V/10A

Digital Volt, Analog Current
PS-8200 ($179.95) 30V/3A
PS-8201 ($239.95) 30V/5A

Digital Volt & Current Display
PS-8300 ($199.95) 30V/3A
PS-8301 ($259.95) 30V/5A

Triple Output

- Independence or Tracking operation
- Parallel to double current output (PS-8102 & PS-8103 only)

Triple Output (Analog displays)
PS-8102 ($399.95) 30V/3A/30V/3A
PS-8103 ($489.95) 30V/5A/30V/5A

Digital Displays
PS-8202 ($499.95) 30V/3A/30V/3A
PS-8203 ($549.95) 30V/5A/30V/5A

AUDIO/RF/FUNCT. GEN.

RF Generator • SG-4160 ($124.95) 100kHz-150MHz sinewaves in 8 ranges
• **SG-4162AD**($229.95) with 6 digit counter
Audio Generator • AG-2601 ($124.95) 10Hz-1MHz, 0-8Vpp sine, 0-10Vpp squarewave
• **AG-2603AD** ($229.95) with 6 digit counter
Function Generator • FG-2100A ($154.95) 0.2Hz-2MHz,5mV-20V_{pp}
• **FG-2103** ($329.95) *Sweep* 0.5Hz-5MHz

GW/INSTEK®

20 MHz Scope

- **OS-620 $324.95**
- Most economical scope
- Dual CH/X-Y operation
- 1 mV/div sensitivity
- Z-axis input,CH1 output
- TV syn, ALT trigger
- 2 probes (x1, x10)

Cursor Readout

- **OS-626G $599.95**
- **Readout & Cursor meas**
- Dual CH / Delay sweep
- Built-in delay line
- ALT trigger, Hold-Off
- Z-axis input,CH1 output
- 2 probes (x1, x10)

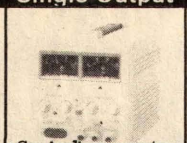
DC POWER SUPPLIES

Triple Output

- 2 variable out 0-30V,0-3A
- One fixed 5V,3A output
- Auto track, serial, parallel
- Const. volt, current mode
- 4 analog or 2 digital display

PC-3030 ($499.95)
PC-3030D ($549.95) digital

Single Output



- Const voltage, current mo
- Voltage regulation ≤0.01%
- Current regulation ≤0.2%

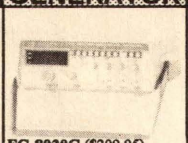
PS-1830 ($198.95) 18V/3A
PS-1850 ($214.95) 18V/5A
PS-1830D($214.95)18V/3A
PS-1850D($244.95)18V/5A

Programmable

- Auto serial/parall.(PPT ser)
- Auto track (PPT series), IEEE-488.2 and SCPI compatible command set

PPS-1860G($1,149.95)18V/6A
PPS-3635G($1,149.95)36V/3.5A
PPT-1830G($1,499.95)18V/3A
PPT-3615G($1,499.95)36V1.5A

FUNCTION GENERATOR



FG-8020G ($209.95)
- 0.02Hz-2MHz w/counter
- Sine/Squ/Tri/pulse/Ramp

FG-8020G ($209.95)
- 0.02Hz-2MHz w/counter

FG-8050 ($449.95) Sweep
- 0.05Hz-5MHz w/counter
- INT/EXT AM/FM mod

BENCHTOP DMM

DM-8034($179.95) 3½ dgt
- AC/DV(V,A),C,Ω,diode

DM-8040($339.95) 3¾ dgt
- ACV to 50kHz, true rms

DM-8055G($889.95)5½dgt
- 0.006% accuracy, GPIB
- dBm,auto,REL, min/max

ALFA ELECTRONICS
P.O. BOX 8089
PRINCETON, NJ 08543-8089

TEL: (800)526-2532 / (609) 897-1135
FAX: 609-897-0206
E-mail: sales@alfaelectronics.com

Call / Write / Fax / Email for FREE CATALOG
Visa, MC, AMEX, COD, PO Accepted. OEM Welcome.
1 Year Warranty (2 Years for GW/Instek)

CIRCLE 213 ON FREE INFORMATION CARD

SEC Sun Equipment Corporation

P. O. Box 97903, Raleigh, NC 27624 E-mail: sunequipco@ipass.net
To request FREE CATALOG, please call, fax, write, or e-mail us.

Quality Test Equipment for Cost-Minded People

LODESTAR Lodestar Electronics Corp. Since 1979

One Year Warranty. 15 Day Money Back Guarantee. OEM WELCOME.
School purchase order accepted. Bids accepted. **VISA, Mastercard Discover, AmrExpr**
SALES REP./DISTRIBUTORS/OEM WANTED.
1-800-870-1955 / (919)870-1955 Fax:(919)870-5720

DC POWER SUPPLY (CC/CV)

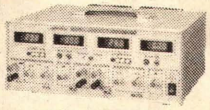
All models: protection of short ckt, overload, reverse polarity, overvoltage; Constant Current & Voltage (CC/CV) are fully adjustable. Regulation: ≤.01%+3mV (line); ≤.01%+3mV (load); ≤1mV ripple.

SINGLE OUTPUT

Analog Displays
PS-303 $159.00, 30V/3A.
PS-305 $219.95, 30V/5A.
PS-1610S $289.00, 16V/10A.
PS-2243 $139.00, 12V/24V select, 3A.
PS-2245 $159.00, 12V/24V select, 5A.
8107 $399.95, 30V/10A.
8110 $289.95, 60V/3A.
8112 $399.95, 60V/5A.

Digital Voltmeter & Analog Ammeter
8200(8201) $179.95($239.95), 30V/3A(5A)
Digital Displays **8210/8300 $199.95**, 30V/3A.
8211/8301 $259.95, 30V/5A.

DUAL OUTPUTS
Independent/Tracking



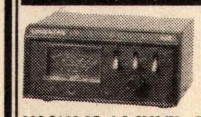
Analog Displays
8108 $549.95, 60V/3A.
8109 $699.95, 60V/5A.
PS-303D $314.95, 30V/3A. **PS-305D $399.95**, 30V/5A.

TRIPLE OUTPUTS, a fixed 5V/3A output, Independ/Tracking
Digital Displays **8202(8203) $499.95($549.95)**, dual 30V/3A(5A).
Analog Displays **8102(8103) $399.95($489.95)**, dual 30V/3A(5A), with *Parallel* (30V/6A) and *Series* (60V/3A) Mode operation.

NTSC/PAL TV COLOR BAR GEN.

CPG-1366A $159.95, VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV.
Impedance: 75 Ohm;
Video Output: BNC, $1V_{p-p}$.
CPG-1367A $159.95, VHF PAL.

SWR/RF/mW POWER METER



310 $89.95, 1.8-150MHz; *RF Power*: 0-4W/20W/200W 3 ranges; *SWR Measurement.*: 1.0~∞, 4W minimum. Accuracy: 5%-10%; *Insert Loss*: .3dB *Input/Output Imp.*: 50Ω; SO-239 plug
320 $89.95, 130-520MHz. Spec. 310.
330 $119.95, 1.8-520MHz. Spec. see 310.
SWR-3P $26.95 1.7-150MHz;
RF Power: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz; *RF Power*: 0.5-10W.

mW RF Power Meter 340 $219.00, 1.8-500MHz; *RF Power*: 20mW/200mW/2W 3 ranges; *Imped.*: 50Ω; *Accuracy*: ±10% full scale; SWR <1.15; N-type connector; BNC type output..

FM STEREO MODULATOR

AG-2011A $549.00
RF SECTION:

Carrier: 98MHz ±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%;*L-R Separation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Separation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz.

WOW-FLUTTER METER

WF-3103A $699.95 *Freq. Range*: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN.

Measuremt: .03/.1/.3/1/3% full scale.
Accuracy: ±5% of full scall.
WF-3105A $799.95, digital display; *Function*: LIN/WOW/Flutter/WTD.
Freq Counter: 10Hz-9.99MHz.
Indication: CCIR/DIN/JIS.

TOOLKITS - ELECTRONIC/PC

9Z45 $29.99 U.S. Patented, 45-pcs. Contents: IC inserter/extractor with securers & bows, 3-prong part retriever, #0 phillips screwdriver, 1/8" flat srewdriver, self-hold tweezers, metal tweezers, extra parts tube, soldering iron, solder, crimping tool, long-nose plier, cutting plier, zipper vinyl case. Bits include: *Phillips*: #0/#1/#2/#3; *Flat*: 1/8"/3/16"/1/4"/9/32"; PZ1/PZ2; T8/T9/T10/T15/T20/T25/T27/T30/T40/T45; *Hex*: 5/64"/3/32"/1/8"/5/32"/3/16"; *Sockets*: 3/16" (5mm)/7/32" (5.5mm)/1/4" (6mm)/9/32" (7mm)/5/16" (8mm).
8G23 $34.99 23-pcs *Contents*: IC inserter/extractor with securer & bows, 3-prong part retriever, 3/16"/1/4" nutdriver, 3/16"/ 1/8" slotted screwdriver, #0/#1 phillips, reversible T10/T15 bits, re-versible #2 phillips/¼" slotted bits, tweezer, long-nose plier, cutter, 6" adj. wrench, soldering iron, solder, crimping tool, zipper case, manual.
Various packages available, call/write/e-mail/fax for detail.

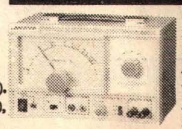
RF SIGNAL GENERATOR

SG-4160B $124.95, 100KHz-150MHz up to 450MHz on 3rd harmonics in 6 ranges; AM modulation; *Accucy*: ±5%. *RF Output*: 100mVrms to 35 MHz; *Modulation*: Int. 1KHz (AM) =30%; Ext. 50Hz-20KHz, at least $1V_{rms}$ input. *Audio Output*: 1KHz, $2V_{rms}$ minimum.
SG-4162AD (with Freq. Counter) $229.95, Spec. see SG-4160B.
COUNTER SECTION: 10Hz-150MHz; *Max. Input*: ≤3V effective *Gate Time*: .1, 1sec. *Input Sensitivity: 35mV, 10Hz-200MHz.* *Input Impedance*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs.

AM/FM STD SIGNAL GEN.

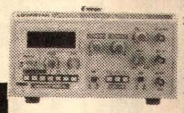
SG-4110A $1799.00, *Freq*: 0.1~110MHz; *Display*: 6-digit LED; Resolution: 100Hz (0.1~34.999MHz); 1KHz (35MHz~110MHz). *Accuracy*: <±($5x10^5$ ±1 count); *Output*: -19dBu~-99dBu, 1dB steps. *Impedance*: 50Ω VSWR 1.2; 100 preset frequency & store functions

AUDIO GENERATOR



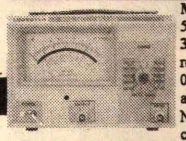
AG-2601A $124.95, 10Hz~1MHz in 5 ranges; *Output*: sinewave 0~$8V_{rms}$; square $10V_{p-p}$. *Output Imped*: 600 Ohm. *Distortion*: <0.05% 500Hz~50KHz; <0.5% 50KHz~500KHz.
AG-2603AD $229.95, with 6-digit, Int/Ext. Freq Counter, 10Hz~150MHz, *Output Control*: 0/-20/-40dB & Fine adjuster. Spec. see AG-2601A.

FUNCTION GENERATOR



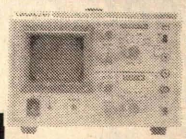
FG-2100A $169.95, 0.2Hz-2MHz in 7 ranges; sne, square, triangle, pulse & Ramp; *Output*: $5mV_{p-p}$-$20V_{p-p}$, 1% distortion. *VCF*: 0-10V/freq. to 1000:1.
FG-2102AD $229.95 see FG-2100A; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
FG-2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG. *Freq. Counter*: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz.
FG-513 $769.95, 13 MHz, Microprocessor embedded dgital sweep; Sine, Square, Triangle, Pulse, Ramp, TTL & DC; ±(.01%+1dgt). *Freq. Counter & TCXO*: 5Hz-100MHz, 6.5 digits. x1/x20 attenuatn

AC MILLIVOLT METER



MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV, dB &dBm; 300μV~100V in 12 ranges, 10μV resolution; -70~40dB in 12 ranges, 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedance 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement..

OSCILLOSCOPES



OS-7305B $249.00 DC~7MHz; 3" CRT; *Horz*: .25V/div; 10Hz~100KHz in 4 ranges; *Vert*: 10mV/div; Int. & Ext. Sync.; *Input*: 1MΩ/35pF.
OS-7010A $299.95 10MHz, 5"CRT, *Horz*: .2V/div; *Vert*:10mV~10V /div.
OS-622G $389.95 20MHz, 2 CH/X-Y Alt trigger, trigger lock, hold OFF, TV syn., 8x10 div., 1mV/div., *Horz*: .2μs~.5s/div; *Vert*: 1mV~5V/div.
OS-653G $699.95 50MHz, 2 CH/delay sweep, Alt trigger, TV syn.
OS-6101G $1499.95 100MHz, 4ch/8 traces, delay sweep, cursor readout. *2 years warranty for OS-622G, OS-653G, & OS-6101G.*

UHF ATTENUATORS

RT-8815U (50Ω) $299.00 / RT-8817U (75Ω) $299.00, 950MHz, 81dB, 0.5W max.; *Steps*: 1/2/3/5/10/20/20/20, 8 switches.
085E-2 (50Ω) $399.00 / 087E-2 (75Ω) $399.00, 950MHz, 81dB, 0.5W max.; *Steps*: 10dB+7.1dBx10, Electronic adjustment knob.

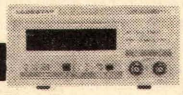
MICROPROCESSOR TRAINER

BGC-8088 $699.00, learn computer theory. Excellent for school & individual who want to learn about ROM, RAM, I/O ports, programming, & run a 8088 Microprocessor. An easy to understand step-by-step manual guides you to achieve your goal. 56-key keyboard, LCD display, RS-232, UART...

GRID DIP METER

DM-4061 $89.95 1.5-250MHz, 6 bands; 6 plug-in coils, 2 transistor, and 1 diode. *Modulation*:= 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absorption meter. 9VDC battery.

FREQUENCY COUNTER



FC-5250C $119.95 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10-200MHz. *GateTime*: .1, 1sec. *Max. Input*: $10V_{p-p}$. *Input Sensitivity*: 35mV/10Hz-200MHz *Input Imped.*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs; 9V adapter (**$6**)

FC-5260A $129.95
10Hz-600MHz. 7-digit LEDs.
FC-5270 $149.95
10Hz-1.2GHz; 8-digit LEDs.
FC-5600B $229.95
10Hz-600MHz; 10-digit LEDs.
FC-5700 $299.95 10Hz~1.3GHz; 10-digit LEDs. Period measure.

SIGNAL TRACER/INJECTOR

SE-6100 $134.95
TRACER: Gain 60dB maximum. *Attenuation*: 0/20/40/60dB *Input Imped*: 100KΩ; *Meter*: Vu 100μA *Output Imped.*: 600Ω; *Speaker*: 8 Ω.
INJECTOR: =1KHz Squarewave; *Output Level*: Variable 0 ~ $4.5V_{p-p}$; 9V battery or adapter (**$6.00**).

LCR METERS

MIC-4070D $179.95, *Induct.*: 0.1μ~200H, *Capacit.*: 0.1p~20mF, *Resist.*: 1mΩ~20MΩ, 2Ω range, Dissipation factor measurement, Zero adjust; Surface mount device (SMD) test probe: **LT-06 $21.95**

DIGITAL MULTIMETER

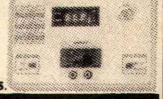
DMM-120 $24.95, 3½ digit, 600VDC, 2ADC 500VAC, 2MΩ, hFE/diode/continuity test; 1.2%
DMM-123+Capacitance $44.95, 3½ digit, 600VDC/600VAC, 10ADC/AC, 2GΩ, 20μF, hFE/diode test, continuity beeper; 0.8% accuracy
DMM-124+Cap.+Temp.+Freq. $69.95, 3½ dig, 600VDC/500VAC, -58~752°F, 2GΩ, 20mF, 200KHz, 3ϕ phase/diode/continuity test; 1.2%.
DMM-125 $54.95, Autorange/Bargraph, 32MΩ, 600VDC/AC, 10ADC/AC, diode/continuity test.
MIC-35 $59.95, Autorange, 3½ LCD, 20MΩ, 1000VDC/750VAC, 20ADC/AC, data hold, diode/continuity test, free holster; 0.5% accuracy
MIC-39 $129.95, Autorange/Bargraph, True RMS, 3¾ LCD, 40μF, 40MΩ, 1000VDC/750VAC, 20ADC/AC, 600KHz freq. cntr, data hold, sleep mode, memory, read functions, holster; 0.3% accuracy.

POCKET ANALOG MULTIMETER AMM-9810P $14.95

DCV: *Range*: 10/50/250/500V; ±4%.
ACV: *Range*: 50/250/500V; ±4%.
DCA: *Range*: 25mA, 250mA; *Accuracy*: ±4% full scale; *Protection*: 0.5A/250V fuse.
Resistance: *Range*: **500kΩ (x 1k)**; ±5%.
dB Test: +4 to +56 dB on ACV range; *Accuracy*: ±5% of full scale.
Battery Test: 1.5V and 9V.
Max. Input: 500VDC/AC, or 250mADC.

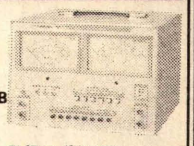
AUTO. CAPACITANCE METER

CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic. *Resolution*: 0.1pF lowest, 0.1% full scale. *Accuracy*: 0.5% of full scale ±1 digit to 99.9μF, 1% of full scale ±1 digit to 99.9μF. *Display*: 3 digit LED. *Unit*: pF, nF, μF, mF, Overrange indicators.



AUTO DISTORTION METER

DM-3104A $799.95

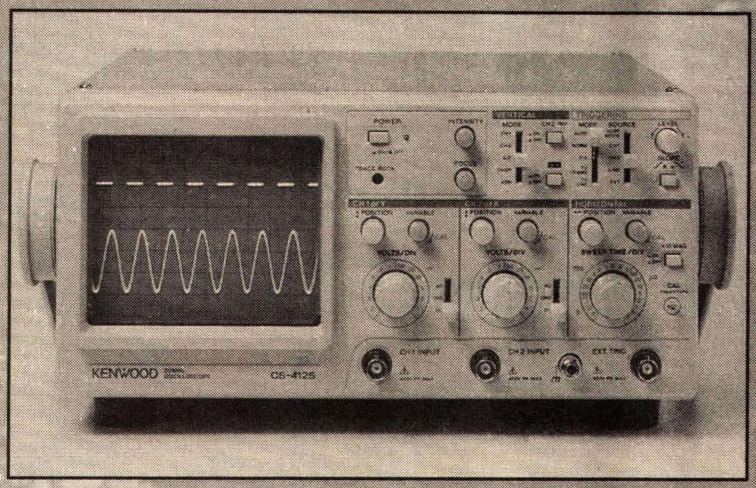


DISTORTION MEASURE
Range: 0.01% to 30%, 0.1/0.3/1/3/10/30% 6 ranges.
Freq: 400Hz±10%, 1KHz±10%(HPF).
Input: 3mV-100V; Ratio measure 20dB
Auto. Freq. Switching Ranges:
Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
LEVEL MEASURE *Range*: 0 to 100V in .03/.1/.3/1/3/10/30/100V
Freq Response: ±0.5dB/20~50kHz; ±1dB/20~100kHz.
DM-3204 $1,599.00 dual channels; Spec see DM-3104A.

CIRCLE 314 ON FREE INFORMATION CARD

KENWOOD

...from the company you've been listening to for years...

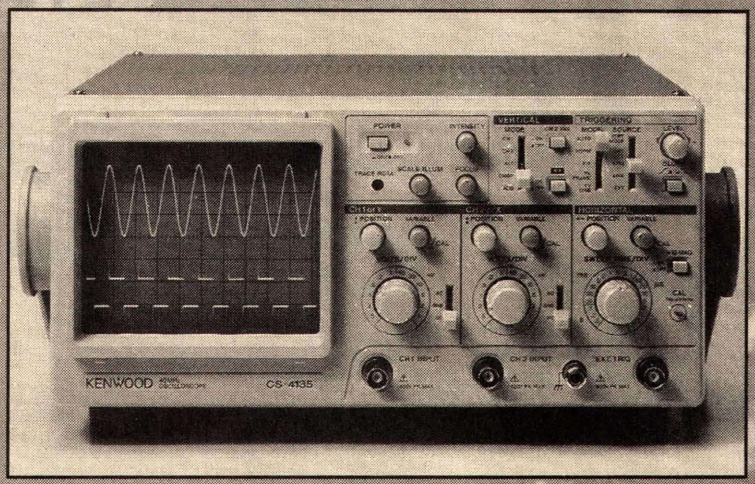


2-Channel, 20-MHz

CS-4125

Regular $595

Sale $389



2-Channel, 40-MHz Oscilloscope

CS-4135

Regular $855

Sale $685

Hybrid IC Technology is the Key to the High Quality and High Reliability at Low Cost!

- **FIX SYNCHRONIZATION** detects the trigger level automatically for the acquisition of stationary waveforms without complicated sync level adjustments.
- **VERT MODE TRIGGERING** enables the acquisition of stationary waveforms for both CH1 and CH2 even when the input signals to the two channels have different frequencies.
- **HIGH WITHSTAND INPUT** voltage of 400V (800Vp-p).
- **RELAY ATTENUATORS** are provided for reliable logic switchover.
- **SCALE ILLUMINATION** (CS-4135 only)
- **DIMENSIONS** (WxHxD): 300(343) x 140(150) x 415(430)mm ( ) including protrusion.
  WEIGHT: approx. 7.2kg (CS-4135) approx. 7kg (CS-4125)

VISA

MasterCard

Card

PRINT™ Products International

Call for your free 84 page test instrument catalog today!!!
8931 Brooklyville Road * Silver Spring, Maryland * 20910
**** Phone 800-638-2020 * Fax 800-545-0058 * www.prodintl.com***

CIRCLE 264 ON FREE INFORMATION CARD

VARIAC

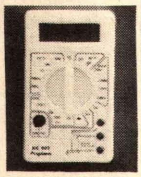
Excellent for controlling & testing various electronic products such as, Motor, Transformer, Lighting Control, School Electronics Lab / ***1000VA***

$69.89

Qty. 3+

DIGITAL MULTIMETER

Basic Digital Multimeter with Transistor ***"hfe"*** and Continuity Test.



Qty. 3+ **$8.50**

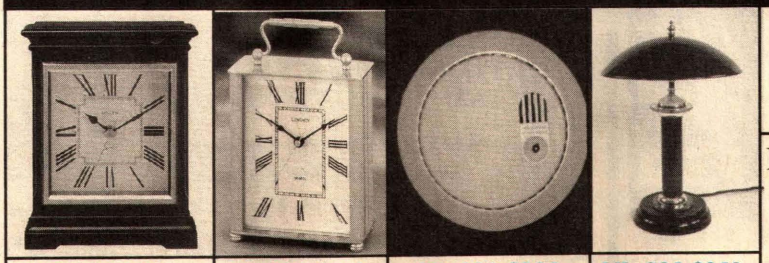
1-888-456-4517

Associated Elec. & Eng.Co./ AEEC
email: aeecpro1@aol.com
website: www.internet-web.net/aeec
PO Box 4766, Santa Clara CA 95056

Source Code:118EN Sale Ends: 11/13/98

www.spysite.com

COVERT SURVEILLANCE: Protect Your Assets



MC-985 $350 | CL-985 $350 | SD-985 $295 | VL-985 $350

EXIT SIGN CAMERA
EX-985 $295

EMERGENCY LIGHT CAMERA
EL-985 $325

All "985" Series Color Cameras Feature:

- Sensor: 1/3" Sharp® Color CCD
- Resolution: Over 380 TV lines
- Sensitivity: Super Low, 2 Lux
- Built-In Backlight Compensation
- Lens: 3.7 mm Pinhole
- Viewing Angle: 92 FOV
- Video Output: Female RCA
- Power: 5V DC (included)

CLOSEOUT

Color Camera Kit:

- 1/2" Sony Color CCD
- 400 TV line Res.
- 2 lux Sensitivity
- Backlight Compensation
- 4 mm Standard Lens
- Wall Mounting Kit
- 5V Power Transformer

SONY-1002 $175

Counter Surveillance: Protect Your Privacy

Protect Yourself From:

- Telephone Taps
- Room Transmitters
- Body Wires

Built-In White Noise Generator

AI-5500 $380

Detects Concealed:

- Tape Recorders
- Video Cameras
- Body Transmitters
- Room Transmitters

LED and Vibration Alert

TRVD-900 $495

Your Payment Options: Credit Card, Cashier's Check, or Money Order

AMERICAN INNOVATIONS, Inc.
119 ROCKLAND CENTER ~ Suite 315 NANUET, NY 10954
Voice: (1)914-735-6127 Fax: (1)914-735-3560

CIRCLE 218 ON FREE INFORMATION CARD

Weeder Technologies

VISA

FREE CATALOG!

MasterCard

Pro-Kit

PO Box 2426, Ft. Walton Beach, FL 32549 **www.weedtech.com** **Voice/Fax 850-863-5723**

Stackable RS-232 Kits

Digital I/O - 12 I/O pins individually configurable for input or output. DIP switch addressable; stack up to 16 modules on same port for 192 I/O points. Turn on/off relays. Sense switch transistions, button presses, 4x4 matrix decoding using auto-debounce and repeat. **$32**

Analog Input - 8 input pins. 12-bit plus sign self-calibrating ADC. Returns results in 1mV steps from 0 to 4095. Software programmable alarm trip-points for each input. DIP switch addressable; stack up to 16 modules on same port for 128 single-ended or 64 differential inputs. **$49**

Home Automation (X-10) - Connects between a TW523 and your serial port. Receive and transmit all X-10 commands with your home-brewed programs. Full collision detection with auto re-transmission. **$39**

Caller ID - Decodes the caller ID data and sends it to your serial port in a pre-formatted ascii character string. Example: "12/31 08:45 850-863-5723 Weeder, Terry <CR>". Keep a log of all incoming calls. Block out unwanted callers to your BBS or other modem applications. **$35**

Touch-Tone Input - Decodes DTMF tones used to dial telephones and sends them to your serial port. Keep a log of all outgoing calls. Use with the Caller ID kit for a complete in/out logging system. Send commands to the Home Automation or Digital I/O kits using a remote telephone. **$34**

Telephone Call Restrictors

Two modes of operation; either prevent receiving or placing telephone calls (or call prefixes) which have been entered into memory, or prevent those calls (or call prefixes) which have "not" been entered.

Block out selected outgoing calls. Bypass at any time using your password. **$35**

Block out selected incoming calls. Calls identified using Caller ID data. **$46**

Phone Line Transponder

7 individual output pins are controlled with buttons 1-7 on your touch-tone phone. Automatically answers telephone and waits for commands. Monitor room noises with built in mic. "Dial-Out" pin instructs unit to pick up phone and dial user entered number(s). Password protected. **$49**

IR Remote Control Receiver

Learns and responds to the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. 7 individual output pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. **$32**

DTMF Decoder/Logger

Keep track of all numbers dialed or entered from any phone on your line. Decodes all touch-tones and displays them on a 16 character LCD. Holds the last 240 digits in a non-volatile memory which can be scrolled through. Connect directly to radio receiver's speaker terminals for off-air decoding of repeater codes, or numbers dialed on a radio program. **$55**

Notch Filters

Test Chips

Beep-Beep

Brochure $1.00

Buzz-Buzz

Filter Kits
1 to 2 $ 20 each
3 to 9 $ 15 each
10 to 20 $ 9 each
21 or more $ 7 each

www.nutnet.com

Adult Wholesale Video's

$ 379.00
Free Shipping

Video Media
P.O. Box 93/6025
Margate, Fl. 33093-6025
(954)-752-9202

MasterCard VISA

SCIENCE FAIR ELECTRONICS
One of the largest electronic kit selection

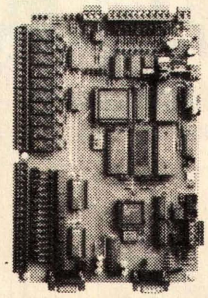
Address: 9740 CAMPO RD. #209
SPRING VALLEY, CA 91977

PHONE: (619) 668-0078
PHONE: 1-800-475-0349
FAX: (619) 668-0054

We Carry Electronic Kits, Robots, Motors, Tools, Test Equipment, batteries, etc.

To receive a *FREE CATALOG* fax or mail your address with phone number to the address above and you will automatically become a member with no extra charge.

SC552ES CONTROLLER



- 80C552 @ 22MHz
- Enhanced BASIC Language
- 6"x9" circuit board
- 10 5A relay outputs
- 3 LED or logic outputs
- 16 opto-isolated inputs
- 8 ch. 10 bit analog inputs
- 2 ch. 8 bit analog outputs
- Real Time clock/calendar
- 128K Static RAM
- 128K FLASH memory
- 256 byte serial EEPROM
- 3 serial ports (RS232/485)
- IIC bus expansion
- Plug-on I/O terminal blocks
- Single 12Vdc operation

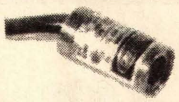
APPLICATION READY ONLY $349.95

MasterCard VISA

SYLVA CONTROL SYSTEMS

519 Richard Street, Thunder Bay, Ontario, Canada P7A 1R2
Ph. 807-768-2487 Fax 807-767-0587
www.sylvacontrols.com info@sylvacontrols.com

LASER MODULE



Auto Power Control
Collimated Laser
Compact Size
100,000 hr lifetime
No Electronics Required

Visible Laser Modules(635-670 nm)
TTL Modulated Laser Modules
Line Generator Laser Modules
Infrared Laser Modules(780-830 nm)

from $ 29 (US)

LASER POINTER

Focus Adjustable
Elegant Design
Solid Metal Body

Pen Style Laser Pointer (1500 ft visibility)
Key Chain Laser Pointer (1500 ft visibility)
Available in silver and, black finish.

$19.95 (US)

World Star Tech. *Ask for free catalog*
Tel:(416)204 6298 Fax:(416)596 7619
http://www.worldstartech.com e-mail: info@worldstartech.com

Printed Circuits in Minutes Direct From LaserPrint!

8 1/2" x 11"
* Or Photocopy
**Use standard household iron or P-n-P Press.

1. LaserPrint*
2. Press On**
3. Peel Off
4. Etch

Press-n-Peel

Use Standard Copper Clad Board
20 Shts $30/ 40 Shts $50/ 100 Shts $100
Visa/MC/PO/Ck/MO $4 S&H
Techniks Inc.
P.O. Box 463
Ringoes NJ 08551
ph. 908.788.8249 fax 908.788.8837
http:\\chelsea.ios.com\~techniks
Retail Dealer Inquires Invited

---

www.jm-micro.com

PIC In-Circuit Emulator
for the PIC16Cxx from $295

PIC Programmer $155

80C552 (8051) Development Training System $235

68HC11 SBC $120

ROMY-16 EPROM Emulator from $195

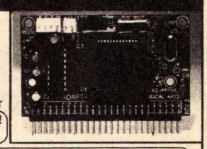
Universal Microprocessor Simulator/Debugger (including Assembler, and Disassembler)
$100 each CPU

***J&M* Microtek, Inc.**
83 Seaman Rd, W Orange, NJ 07052
Tel:(973)325-1892 Fax:(973)736-4567

ADAPT-11
68HC11 Modules for Solderless Breadboards

- miniature 2.0" by 2.8" module
- plugs vertically into solderless breadboard for easy development
- BOOT/RUN switch for easy programming via PC serial port
- all I/O lines on dual row connector

Complete modular prototyping system! Expansion accessories available!



For just U$74.95, our Starter Package (AD11SP) provides everything you need to get going fast! Now you can harness the power of the popular 68HC11 in your projects! Includes ADAPT-11 with 68HC811E2, providing 2K EEPROM (re-programmable), 8 channel 8-bit Analog-to-Digital Converter (ADC), hardware timers, counters, interrupts, Serial Peripheral Interface (SPI), Serial Communications Interface (SCI), & more! On-board RS-232 interface (cable included), 5-volt regulator, 8MHz crystal, reset circuit, and convenient program/run switch. Comes with non-commercial versions of 'HC11 Assembler, BASIC, & C, as well as handy utilities & example code. Includes Motorola 68HC11 Pocket Programming Reference Guide and manual with schematic. All you need is a PC to write & program your software, a DC power supply, and a solderless breadboard (or protoboard) to build your application circuits on (or use our modular accessories).

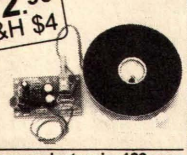
Visa • MasterCard • AmericanExpress • Discover

TECHNOLOGICAL ARTS
309 Aragona Blvd., Suite 102, Box 418, Va. Beach, VA 23462
1644 Bayview Avenue, Box 1704, Toronto, ON M4G 3C2
voice/fax:(416) 963-8996 www.interlog.com/~techart

Intercom Kit

$12.95 +S&H $4

Two station. Two wire. Each unit with its own speaker, microphone and amplifier (LM386). Can be modified to a hard wired 'bug'. Power can be send to the remote 'bug' unit from the receiving unit. All components, PCB and Instructions included.



www.electronics123.com

Music to Light Modulator

$7.95 +S&H $3

Complete electrical isolation between input audio signal and output light modulation Power handling: 220 Watt. Money Back Guarantee.

USA: Amazon Electronics, PO Box 21, Columbiana, OH 44408, USA

AFRICA: *Archimedes Products, Tel (012) 332-2356, PO Box 26603, Gezina, 0031, South Africa*

Toll Free 1-888-549-3749 (USA & Canada)
We have lots of other electronic kits, books, science kits, components, enclosures, etc.
Request a FREE catalog.

FRIENDLY LITTLE
MICRO CONTROLLER

$149 (single)

...packs a ***MEAN*** punch
a.k.a. "Steroid Stamp"

- 39 I/O + 8 A/D (10 bit) •
- 128K SRAM + 128K Flash •
- LCD/Keypad Interface •
- Fast 16 bit Motorola CPU •
- Affordable C Compiler •
- Comprehensive s/w Library •

Intec Automation Inc. v: 250-721-5150
www.steroidmicros.com fx: 250-721-4191

OVER 30,000 ITEMS IN STOCK

LARGE VARIETY
SAME DAY SHIPPING
Minimum Orders $20.00
Not Including Shipping &Handling

Dalbani®

The Ultimate Saving Source

SEMICONDUCTORS

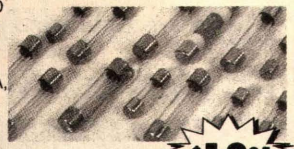
Original #	Brand	Replaces
7805	Tesla	960
7806	Ank	962
7809	Ank	1910
7810	Samsung	1968
7812	Tesla	966
7815	Tesla	968
7818	Tesla	958
7824	Tesla	972
7905	Tesla	961
7906	Tesla	963
7908	Tesla	965
7912	Ank	967
7918	Tesla	959
7924	Tesla	971

YOUR CHOICE
45¢ each

POPULAR FUSE KIT — 180 Piece Kit

Kit Contains 10 Pieces of each of these items:
- AGC Type : 0.5A, 1A,1.5A, 2A, 2.5A, 3A, 4A, 5A, 6A, 10A, 15A
- Ceramic Type : 15A
- GMA Type : 1A, 1.5A, 2A, 3A, 4A, 5A

Everything Comes in a Durable Plastic Box



$13.95

Item # 10-2050

TUN-O-WASH® (CFC Free)

Fast drying electronics grade cleaner for tuners, controls and PC boards.
- CFC and HCFC free
- Not for use on energized equipment

* Due to the chemical content, this product can be only shipped by UPS ground service.

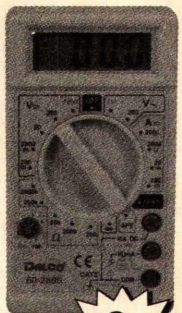
Item # 30-0100
(12.5 Oz aerosol)

$11.75

DALCO DIGITAL MULTIMETER

- DC Voltage: 200m-1K
- AC Voltage: 200-750V
- DC Current: 20m-20
- Transitor and Diode Test
- Continuity Buzzer
- Polarity indicator appears on LCD
- Test Probes Included
- Dimensions: 4.96" x 2.76" x 9.4"
- Weight: 6 oz.
- 9V Battery Included

Item # 50-2895



$9.95

Dalco® ECONOMICAL SOLDER WICK

5 Feet — *Removes solder easy*

- Length: 5 feet
- Width: 0.15"
- Safer Desoldering
- Fast Response .

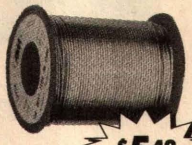
Item # 51-1050

$1.10

SOLDER ROLL

- 1 LB Spool
- 370º F melting point
- Fastest solder
- Alloy 60/40,tin lead,non corrosive flux, Diam.1.0mm

Item # 51-1005



$5.49

DUAL HELPING HANDS

- Hold Work in any Position to leave hands free for soldering

Item # 50-1325

$3.45

SOLDERING IRON

- General Purpose Applications
- 117V AC, 30 Watts

Item # 51-1335

$3.25

WELLER WLC100 SOLDERING STATION

Weller

$38.90

- Ideal for the professional, serious hobbyist
- Variable power control (5-40W)
- 40W pencil iron and ST# inter changeable tip
- Replaceable heating element
- Cushioned foam grip • Safety guard iron holder
- On/off switch with "power-on" indicator light

Item # 51-1505

SHIP UP TO 5lbs FOR ONLY
$3.95
UPS 2ND DAY AIR
Plus handling & C.O.D. charge if it applies

THE MOST POPULAR VCR ALIGNMENT TOOL KIT

$24.99

- VCR Head pull
- Retaining ringremover
- Micro screwdriver
- Fitted vinyl Case
- Spring hook
- Hex key set
- Soft zippered case
- 7 Assorted head & guide aligner
- Dimensions: 9 1/2"(W) X 12 1/4"(L)
- 3 Reverseable screwdrivers (Small-Flat-Phillips)

Item # 50-888

HEAVY DUTY COLOR CODED LEADS

$2.95

- 10 Leads
- 11" Long Wire Lead
- Insulated 11/2" Alligator Clips
- 20 Gauge Wire Size
- Black, Green, Red, Yellow, White

Item # 56-500

Dalco® SWING ARM MAGNIFIYING LAMP

$36.72

White Color

- Spring-Balanced 45" extension arm with 3 conductor cord 120V 60Hz
- Steel Shade supplied with a precise 3 diopterlens and a 22W fluorescent circline tube
- .Comes with a lamp

Item # 54-0120

Dalbani®
4225 NW 72ND AVE. MIAMI, FLORIDA 33166
TEL : (305) 716-1016 ----- FAX : (305) 594-6588

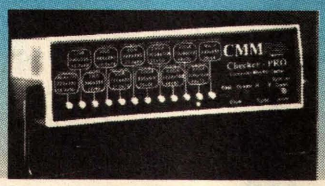
Free 400 Page Color Catalog With your First Order

1-800-325-2264

CIRCLE 234 ON FREE INFORMATION CARD

CMM
Monitor/TV Test Equipment

Checker Pro



There is the Computer monitor tester you have been asking for. Sweep rates to 15-64 kHz, MGA, CGA, VGA, lots of MACs, even video (mono), GRAY SCALE, quick push button operation, "Energy Star" testing, and more. AC or Battery.

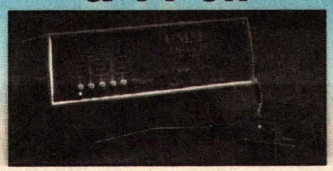
PRICE: $499.95

Checker 12e

Now you can repair and test Computer monitors with ease. With sweep rates up to 64Khz., eight step gray scale, white screen, single color mode. Mac II, EGA, CGA support, you can run almost ANY PC monitor. And it is EASY to use. Color front panel displays show just what you should see. Don't let its' small size fool you. It is the most powerful handheld available, and it supports ALL basic VGA modes (some don't). It is suitable for bench or field operations. Battery or AC operation.

PRICE:$295

Checker TV Pro & TV Jr.



The TV Pro is just the tool for your repair bench. It provides Video, S-Video, and RF outputs. It also has the most important pattern, GRAY SCALE! You can't set up a color TV without it All with NTSC standards and COMPLEX sync. The RF output also includes an audio tone and STEREO signaling With colorbars, gray scale, crosshatch with dots you can set and test quickly.

Checker TV Pro..PRICE: $499.95

The TV Jr is a small NTSC video generator with colorbars crosshatch with dots. white. red. blue green. and black screens Small enough to fit in your pocket. powerful enough to drive the largest projection TV!

Checker TV Jr....PRICE: $129.00

Computer & Monitor Maintenance, Inc.

1-800-466-4411 • 770-662-5633

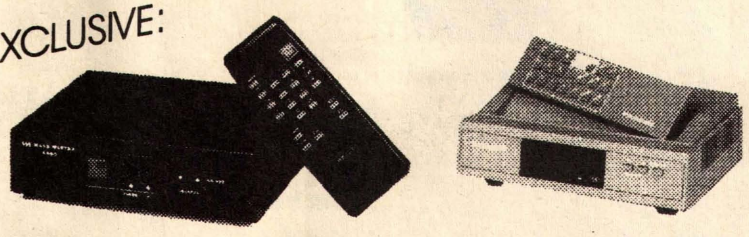
http://www.computermonitor.com

ATTENTION DEALERS: WHOLESALE ONLY!

JAMES' ELECTRONIC SERVICES, LTD.
Formerly JES, Inc.

BEST PRICES!
FAST SERVICE
SAME DAY SHIPPING

EXCLUSIVE:



2 PIECE SETUPS: $85.00

10 lot • 1 Year Warranty

Latest Technology • Universal Combo's - Ask For Details

CALL US LAST! LOWEST PRICES GUARANTEED!

TOLL FREE: 800-322-9690

VISA MasterCard

FAX: 516-246-5634

ABC ELECTRONICS 315 7TH AVE N. MPLS. MN. 55401
(612)332-2378 FAX (612)332-8481 E-MAILSURP1@VISI.COM
WE BUY TEST EQUIPMENT AND COMPONENTS.
VISIT US ON THE WEB AT WWW.ABCTEST.COM

HP 8901A MODULATION ANALYZER	$2100.00	TEK 2465A 350MHZ 4CH. OSCILLOSCOPE	$3500.00
HP 8165A 50MHZ PROG. SIGNAL SOURCE	$1700.00	TEK TDS320 1OOMHZ DIGITAL O-SCOPE	$1700.00
HP 436A RF POWER METER NO CABLE OR SENSOR	$700.00	TEK 465 100MHZ OSCILLOSCOPE	$400.00
HP 8559A/853A .01-21GHZ SPECTRUM ANALYZER	$3500.00	TEK 475 200MHZ OSCILLOSCOPE	$500.00
HP 1740A 100MHZ OSCILLOSCOPE	$250.00	TEK 496P 1KHZ-1.8GHZ SPEC. ANALYZER	$4000.00
HP 8350B SWEEP OSCILLATOR MAINFRAME	$2900.00	TEK 576 CURVE TRACER	$2500.00
HP E3617A 0-60VDC 1AMP DIG. READOUT	$275.00	TEK CG5001 PROG.O-SCOPE CAL.GEN.	$2000.00
HP 3325A SYNTHESIZER/FUNCTION GENERATOR	$1100.00	TEK PS5010 POWER SUPPLY	$450.00
HP 3325A OPT.01 HIGH STABILITY TIME BASE	$1350.00	TEK 7L12 SPECTRUM ANALYZER	$1350.00
HP 6034A 0-60V 10A DIG.DISPLAY	$900.00	TEK 485 350MHZ OSCILLOSCOPE	$650.00
HP 5335A 200MHZ COUNTER	$800.00	TEK 454 100MHZ OSCILLOSCOPE	$300.00
HP 3488A SWITCH/CONTROLLER	$550.00	TEK TM5006 POWER FRAME	$250.00
HP 2804A QUARTZ THERMOMETER	$300.00	TEK 11A32 400MHZ 2CH AMPLIFIER	$750.00
HP 4140B PICO-AMP METER/DC VOLTAGE SOURCE	$3500.00	TEK 11A34 300MHZ 4CH AMPLIFIER	$900.00
HP 54201A 300MHZ DIG.OSCILLOSCOPE	$1500.00	TEK 11A52 600MHZ 2CH AMPLIFIER	$400.00
HP 8011A PULSE GENERATOR	$250.00	TEK 11A71 1GHZ 1CH AMPLIFIER	$300.00
HP 3455A DMM	$250.00	TEK 11302A 500MHZ PROG O-SCOPE FRAME	$750.00
HP 3497A DATA ACQUISITION/CONTROL UNIT	$600.00	TEK 11401 500MHZ PROG. O-SCOPE FRAME	$750.00
HP 86290A RF PLUG IN 2-18GHZ	$1200.00	TEK 11402 1GHZ DIG.PROG. O-SCOPE FRAME	$1000.00
HP 86603A RF PLUG IN 1MHZ-2.6GHZ	$1700.00	TEK TM506 POWER FRAME	$100.00
HP 86601A RF PLUG IN .01MHZ-110MHZ	$400.00	TEK 7104 1GHZ OSCILLOSCOPE FRAME	$1250.00
HP 86632B AM/FM MODULATION PLUG IN	$750.00	TEK AM503 CURRENT PROBE AMPLIFIER	$350.00
HP 1631D LOGIC ANALYZER	$300.00	TEK 7B92A TiME BASE	$125.00
HP 8640B OPT.002 1GHZ AM/FM SIGNAL GEN.	$1400.00	TEK 7S12 SAMPLING PLUG IN	$350.00

BUGGED??

EAVESDROPPING is unbelievably widespread! Electronic Devices with amazing capabilities can be monitoring your telephone and room conversations RIGHT NOW! Are you sure you're safe? FREE CATALOG tells you fast! Includes Free Bonus details on fantastic opportunities now open in Counter-Surveillance field. Exciting, immensely interesting and EXTREMELY profitable (up to $250 hr) full/part-time income. Call Now! 1-800-732-5000

CABLE TV CONVERTERS

Equipment & Accessories
Wholesalers Welcome

Call C&D ELECTRONICS
1-888-615-5757 M-F 10a-6p

MY PERSONAL GUARANTEE with the New & Improved DEN-ON SC7000Z

More Vacuum

Lane Norman - Norman's Electronics Inc. Atlanta GA 404-451-5057
A cost effective solution to desoldering equipment at less than half the price of most equipment. It's performance is ASTOUNDING.

Mike Murphy - Service Center -Van Nuys CA 818-785-7805
The single best investment of repair equipment we've made. It outperforms all other desoldering tools we've used. Easier to use and least expensive.

Quicker Vacuum

George McKinzie - MCK Electronics, Inc. - Nisswa MN - 218-963-4400
A marvelous instrument, a real time saver and has a tremendous vacuum for it's size. The size and portability is also a great advantage.

Dick Manning - Dicks Electronics - Hartland WI 414-367-8339
The ease & speed of component removal greatly increases productive time. The SMD kit makes SMD removal a breeze, even for inexperienced Techs.

George Hefner - Hefner Electronics - Coleridge NE 402-283-4333
Being a one-men service center, I hesitated to spend the money on a desoldering tool , however all that changed when I nearly ruined a $400 computer logic board. It has cut my desoldering time by 50%

FREE TRIAL
Available on Request

Sale Price $395.00

Price includes stand worth $25.00 one extra filter, and two tip cleaners.

Don Cressin - Certified Electronics Service - Ellicott City MD 301-461-8008
We have obtained excellent results with the SC7000Z including repairing high density U/V tuners. It is one of the best purchases we have made.

Doug Pettit - LuRay Electronics - LuRay VA 703-743-5400
We found that the SC7000Z not only saves money vs. wick, but saves valuable time in troubleshooting. It allows you to be more accurate in removing SMD's.

Randy Whitehead - Service West - Salt Lake City UT 801-262-4069
My Techs thought it would be a waste. I bought one anyway after a demo. My Techs then fought over it. Now we have three. It is the Best desoldering tool we have ever used.

Service Managers, Owners, CEO's, CFO's

My personal guarantee to you is that after 90 days of ownership, if you are not convinced that you have made a wise decision for your business with the purchase of the SC-7000Z desoldering tools, your investment will be fully refunded with the return of the merchandise. Now you have no reason not to try it.

Jerry Howard, President.

Check us out on the WEB
http://www.heinc.com
Order from web site for 5% discount

New Specifications

- **Voltage**——AC100V,120V,230V,50/60Hz
- **Power Consumption**——120W
- **Pump**——Diaphragm Type
- **Motor Output**——12W
- **Vacuum Attained**——**650mmHg**
- **Temperature Range**——300°C—**500°C** (572°F—**932°F**)
- **Air Flow Rate**——15 Liter/Minute (Open)
- **Heater**——100W (Ceramic)
- **Control System**——Feed Back Zero Cross-over Type
- **Net Weight**——420Grams
- **Max.Temp. of Hot Blow**——400°C
- **The Most Cost Effective Desoldering Tool in the World.**

- Totally Self Contained diaphragm vacuum pump and AC motor for high vacuum suction or reversible hot air blow for SMD removal.
- 100Watt Ceramic heater with zero-crossover switching heater control circuit which prevents spikes and leakage currents.
- Unique patented long lasting filter cartridge design. Solder builds up on easily cleaned baffle, while air flows around the outside of baffle.
- Totally ESD Safe. The housing contains carbon and the tip is at

Visa - M/C - Discover - American Express - Terms to Qualifying Companys
30 Day Money Back Total Satisfaction Guarantee - One Year Parts and Labor Warranty

HOWARD ELECTRONIC INSTRUMENTS INC
Your Desoldering Specialists

Toll Free U.S. and Canada 1-800-394-1984

Web Site www.heinc.com
E-Mail sales@heinc.com
International (316) 744-1993
or Fax (316) 744-1994

CIRCLE 331 ON FREE INFORMATION CARD

CALL TOLL FREE
(800) 292-7711 orders only
Se Habla Español

C&S SALES
EXCELLENCE IN SERVICE

LOOK FOR OTHER MONTHLY SPECIALS ON OUR WEBSITE

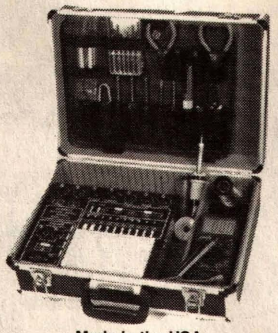
XK-700 Digital / Analog Trainer

Elenco's newest advanced designed Digital / Analog Trainer is specially designed for school projects. It is built on a single PC board for maximum reliability. It includes 5 built-in power supplies, a function generator with continuously sine, triangular and square waveforms and a 1560 tie point bredboard area. Tools and meter shown optional. (Mounted in a professional tool case made of reinforced metal).

XK-700 Assembled and Tested
$189.95

XK-700 - SEMI KIT w/ Fully Assembled PC Board
$174.95

XK-700K - Kit
$159.95



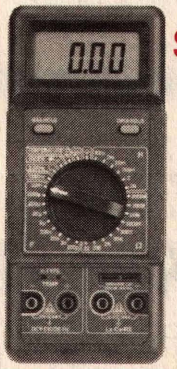
Made in the USA

Digital Multimeter Model M-1740

$39.95
Free Holster

11 functions
- Freq to 20MHz
- Cap to 20m F
- AC/DC Voltage
- AC/DC Current
- Beeper
- Diode Test
- Transistor Test
- Meets UL-1244 safety specs

DIGITAL LCR METER Model LCR-1810



$99.95

- Capacitance .1pF to 20MF
- Inductance 1µH to 20H
- Resistance .01 to 2000M
- Temperature -20°C to 750°C
- DC Volts 0 - 20V
- Frequency up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

15pc. VCR Service Tool Kit Model TK-1400

- Inclined Base Screwdriver
- Eccentric Screwdriver
- 2mm & 3mm Fine Adjust Screwdriver
- VHS VCR Head Puller
- Retaining Ring Remover
- 3 Reversible Screwdrivers
- Spring Hook Tool
- Micro Screwdriver
- Hex Wrench Set

Special
$24.95

Model M-6100

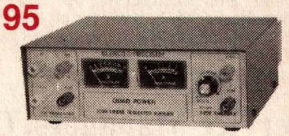
The M-6100 is Elenco's most sophisticated meter with almost every possible feature available. The M-6100 even has a computer interface for viewing and storing data on a personal computer. It comes complete with software, RS-232 cable, test leads and manual.

$99.95

Model XP-581

4 Fully Regulated DC Power Supplies in One Unit
4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A
1 Variable - 2.5 - 20V @ 2A

$89.95



Tektronix DMMs

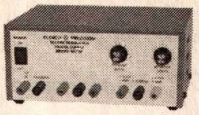
For high performance digital multimeters that are accurate, reliable, and rugged, the DMM900 series extends the Tektronix line of already affordable DMMs. Twice the accuracy. Up to 10 times the resolution. And a full range of capabilities that span voltage, current, dual numeric display, 3 year warranty, and autoranging capability. All backed by the reliability of the Tektronix brand.

912	$179
914	$229
916	$275

Power Supply Kit Model XP-720K

3 fully reg. DC supplies
1.5VDC - 15VDC @ 1A
-1.5VDC to -15VDC
5VDC @ 3A
Plus
6.3VAC @ 1A and
12.6VAC C.T. @1A

$54.95



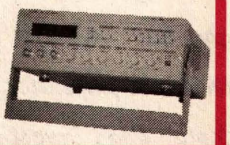
Available assembled Model XP-720 $84.95

Sweep Function Generator

with built-in Frequency counter
Model GF-8026

$225

- Range .02Hz - 2MHz
- Sine, Square, Tringle, Pulse, Ramp
- Ext. counter 1Hz - 10MHz



Kit Corner

over 100 kits available

AK-700

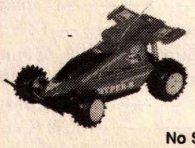
$15.95

Phone kit with training course
4 Flashing neon lights
See thru case

RADIO CONTROL CAR KIT

MODEL AK-870

- 7 functions
- Remote control included



$24.95

No Soldering Required

Digital Capacitance Meter Model CM-1555

$48.95

- Capacitors from .1pF to 20M m F
- 3 1/2 Digit LCD
- Zero adjust
- special insertion jack
- 1/2% basic accuracy
- Tilt stand

Digital Audio Generator

with built-in Counter
SG-9300

- 10Hz - 1MHz
- Low Distortion
- Sine/Square waves
- Built-in 150MHz Frequency Counter

$175

SG-9200 Analog/No counter $119.95

Model AM/FM-108K Transistor Radio Kit

with training course

$29.95

Free Stand

35mm Camera Kit

Learn all about photography
AK-540

$14.95

No Soldering Required

SATELLITE FINDER Model SF-01

- Aligns Satelite Dishes
- Range 950-2050MHz
- Compact Size
- Self Power Check

$39.95

RF Generator

with Counter
Model SG-9500

$225

- 100KHz - 150MHz
- Internal AM Mod of 1KHz
- RF Output 100MV - 35 MHz
- Audio Output 1KHz @ 1V rms

SG-9000 Analog/No counter $119.95

WE WILL NOT BE UNDERSOLD

UPS SHIPPING: 48 STATES 5%
OTHERS CALL FOR DETAILS
IL Residents add 8.25% Sales Tax

C&S SALES, INC.
150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (847) 541-9904 (847) 541-0710
http://www.elenco.com/cs_sales/

VISA MasterCard

15 DAY MONEY BACK GUARANTEE
FULL FACTORY WARRANTY
PRICES SUBJECT TO CHANGE WITHOUT NOTICE

CIRCLE 322 ON FREE INFORMATION CARD

Same Day Shipping

C & S SALES

Your one stop source for all your electronic needs!

CALL OR WRITE FOR OUR NEW FREE 64 PAGE CATALOG!
(800) 445-3201

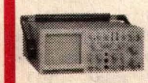
Fluke Scopemeters

123 ..... NEW $950
92B $1445
96B $1695
97 ..... $1695
99B ..... NEW $2095
105B $2495

ALL FLUKE PRODUCTS ON SALE

B & K PRECISION SCOPES

20MHz DUAL-TRACE
Model 2120B - 2 Year Warranty
Special $375
Model 2125A with delayed sweep
$539.95



- 1mV/division sensitivity
- AUTO/NORM triggered sweep operation
- AC, TVH, TVV and line coupling
- Calibrated 19 step time-base with x10 magnifier
- Compact low-profile design

Affordable Spectrum Analyzers by B&K

500MHz Series BK2615A $1250 BK2620A $1675

- 150KHz to 500MHz
- Dynamic Range 80dB(113dB with attenuation)
- +20dB maximum input
- 12.5 and 400KHz resolution bandwidth
- 150KHz/hour stability
- Built-in tracking generator(Model 2620A)

1.05GHz Series BK2625A $1925 BK2630A $2595

- 150KHz to 1050MHz
- Dynamic Range 80dB(113dB with attenuation)
- AM & FM demod included
- 20 and 400KHz resolution bandwidth
- 150KHz/hour stability
- Built-in tracking generator(Model 2630A)

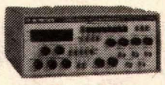
PORTABLE SEMICONDUCTOR TESTER

B&K 510
$199.00

- In or out-of-order circuit tests for transistor, FETs, SCRs and darlingtons.

20MHz Sweep / Function Generator with Freq Counter

B&K 4040



- 0.2Hz to 20MHz
- AM & FM modulation
- Burst Operation
- External Frequency counter to 30MHz
- Linear and Log sweep

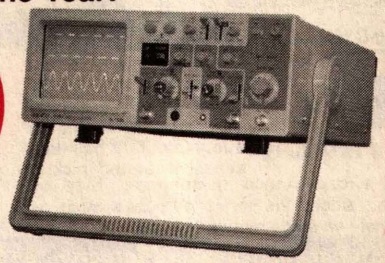
$399

10MHz B&K 4017 $309
5MHz B&K 4011 $239

Quality Scopes by Elenco

Lowest Prices of the Year!

Includes Free Dust Cover and Probes



60MHz

DS-603 $995
- Analog / Digital Storage
- 20MS/s Sampling Rate
- RS232 Output

S-1360 $749
- Analog with Delayed Sweep
- Component Tester

100MHz

S-1390 $895
- Analog w/ delayed sweep
- Dual Time Base
- TV Sync

40MHz

S-1345 $569
- Analog with Delayed Sweep
- Component Tester

S-1340 $475
- Analog / TV Sync
- 1mV Sensitivity

2 Year Warranty

25/30MHz

DS-303 30MHz $895
- Analog / Digital Storage
- 20MS/s Sampling Rate
- RS232 Output

DS-203 20MHz $695
- Analog / Digital Storage

S-1330 $439
- 25MHz Analog
- Delayed Sweep

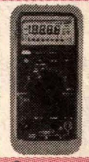
S-1325 $325
- 25MHz Analog
- TV Sync
- 1mV Sensitivity

Fluke Multimeter Specials

F-73III $115 — List $129

F-75II $129 — List $149

F-79II $175 — List $199



F-87 $289 — List $335

B&K Precision Multimeter Specials

- Accurately measures capacitance, resistance and inductance.
- Measures dissipation factor of capacitors and Q of inductors.
- Simultaneously displays measured value and Q or dissipation factor.
- Displays the difference between measures and reference values.

Model 878 $219.95

- 50,000 count
- 0.025% DCV
- 0.07% ohms
- Min/Max/Avg
- True RMS, AC, or AC+DC
- 100kHz AC response
- Capacitance to 50,000m F
- Frequency, duty cycle, pulse width
- dB across 1 to 10k
- Disturbance indicator
- Autograph, bargraph with zoom
- Sealed case, Splachproof
- IEC 1010, class 2 safety compliance

Model 5390 $295.00

MX-9300

Four Functions in One Instrument

Features:

- One instrument with four test and measuring systems:
  - 1.3GHz Frequency Counter
  - 2MHz Sweep Function Generator
  - Digital Multimeter
  - Digital Triple Power Supply
- 0-30V @ 3A, 15V @ 1A, 5V @2A

$459.95

GUARANTEED LOWEST PRICES

UPS SHIPPING: 48 STATES 5%
OTHERS CALL FOR DETAILS
IL Residents add 8.25% Sales Tax

C&S SALES, INC.
150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (847) 541-9904 (847) 541-0710
http://www.elenco.com/cs_sales/

VISA MasterCard

15 DAY MONEY BACK GUARANTEE
FULL FACTORY WARRANTY
PRICES SUBJECT TO CHANGE WITHOUT NOTICE

CIRCLE 322 ON FREE INFORMATION CARD

Mark V Electronics, Inc.
8019 E. Slauson Ave.,
Montebello, CA 90640
Catalog 323/ 888-8988
Fax 323/ 888-6868
http://www.mark5co.com
Email: mark5co@aol.com

DIY Audio Electronic Kits
Lab Equipment kits
Audio Enclosures & more!

ORDER
1-800-521-MARK
1-800-423-FIVE

Kit skill levels
▲ Beginner
▲▲ Intermediate
▲▲▲ Advanced

- Fast Shipping
- Quality Kits low prices
- In business since 1985

SCHOOL PROJECT CORNER

po orders welcome from schools

Melody Generator	▲	Kit	$ 8.85
6W Mini-Amplifier	▲		9.50
0-15V 5A Regulated DC PS	▲		17.50
36W Class A Power Amp.	▲▲		32.50
Dynamic Noise Reduction	▲		26.00
Multi-Function Control Switch	▲		5.25
20 Bar/Dot Level Display	▲▲		41.45
Microphone Mixer Mono Amp.	▲		20.79
Superior Electronic Roulette	▲		9.99
Digital Clock with Melody Alarm	▲		25.00
Stereo Pre-Amp with Mic Amp.	▲		10.78
Mini Stereo Multi-Input Amp.	▲		30.50
130-in-one Electronic Lab	▲		29.99

SEE OUR CATALOG FOR MORE KITS !

FM Wireless TY-35 Microphone

50% off

Kit $ ~~12.50~~ 6.99

This is a low power real FM transmitter. Transmit frequency within 88-108 MHz. Transmit range about 200 ft. It has high sensitivity sound pickup by a capacitance microphone. May be used strictly for series purposes such as remote wireless monitering.

4½ Digital LED Panel Meter SM-48

50% off

Kit $ ~~39.00~~ 20.00

This precision digital meter is a stand-alone voltmeter-ammeter or can interface with a computer! 4½ digit 0.55" LED display. Temperature compensated to 100 PPM/°C. Operating temperature range is 0°C to +70°C. Outputs include BCD date, Busy and strobe. Panel reading can be latched on hold.

Stereo Loudspeaker Protector

TY-25 ▲

Kit: $ 16.75

Super fast acting relay protects speakers against destructive DC voltages. Can connect directly to a power amplifier or can use a separate power supply. Has a 3 second turn-on delay to avoid turn-on thumps.

Regulated DC Power Supply

TR-503 ▲▲

Kit: $ 18.75

It is short circuit proof & has overload protection. Output voltage is variable over a range of 0-50 volts. Current limit trip is adjustable up to max of 3A. May use Mark V #002 transformer.

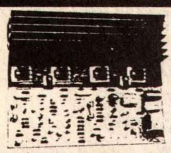
Fluorescent Light Driver

TY-2 ▲ (1 lb.)

Kit:$ ~~14.75~~ 9.99

This unit drives 6-40 watts fluorescent light for portable and emergency use. Works from a 7.2 - 16 VDC battery. Includes a "Hi-Efficiency Switching Mode IC Driving Circuit" suitable for use with different lights.

120-250W Mosfet Power Mono Amplifier AF-2 (6 lbs.) ▲▲



Kit: $ ~~89.80~~ 76.33 Asmb.$ 114.80

Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). 120W into 4 ohms RMS(33VX2 4A transformer is used). Frequency Response: 3Hz-22,000Hz. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47k. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. May use Mark V model 012 Transformer. Suggested Capacitor 8,200uf 100V Model 020. Suggested Metal Cabinet LG-1925.

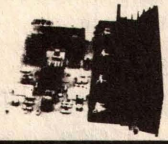
20 Color LED Audio Level Meter ▲

TY-13 (1 lb)

Kit:$ ~~23.50~~ 9.99

Use this dual LED display indicating meter with your stereo power amplifier to indicate instantaneous speaker power. Operating range is -30dB to +5dB and can be calibrated to operate with 1 to 200 W amplifiers. Not consume any amplifier power. A peak LED illuminates on overload!

300W High Power Mono Amplifier TA-3600 (5 lbs.) ▲▲▲



62.30
Kit:$ ~~89.00~~
Asmb.$ 115.00

Power Output: 300W into 8 ohms RMS. 540W music power into 8 ohms. Frequency Response: 10Hz-20KHz. THD: < 0.05%. Sensitivity: 1V RMS at 47K. Power Requirement: 60 to 75 VDC at 8A. May use Mark V Model 007 or 009 Transformer. Suggested Capacitor: 8,200uf 100V Model 020 Capacitor. Suggested Metal Cabinet LG-1925.

500-in-one Electronic Lab Kit

KA-904

$ 129.99

Contains its own computer with a simple explanation of the basic(Assembler) language required for operation. Compile programs to discover how computers operate while gaining an understanding of hardware & software. With easy-to-follow manual which explains by comprehensive diagrams. Requires 4 "AA" batteries.

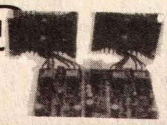
120W + 120W Pre & Main Stereo Amplifier TA-800MK2 (4 lbs.) ▲▲

Kit: $ ~~67.92~~ 57.73 Asmb.$ 86.95

Power Output: 120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response: 10 - 20 KHZ. THD: < 0.01%. Tone Control: Bass ±12dB, Mid ±8dB, Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40V DC @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Metal Cabinet Model LG-1924.

80W + 80W Pure DC Stereo Main Power Amplifier TA-802 (4 lbs.) ▲▲

Best Sell



39.94
Kit: $ ~~49.94~~
Asmb.$ 69.94

Power Output: 80W per channel into 8 ohms. THD: < 0.05%. Frequency Response: DC to 200 KHZ, -0 dB, -3dB @ 1W. Power Requirement: 30V AC X 2 @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Capacitor 8,200uf 50V Model 017. Suggested Metal Cabinet LG-1924

60 + 60W Stereo Power Amp. ▲▲

SM-302 (11 lbs.)

Kit:$ ~~85.00~~ 76.50

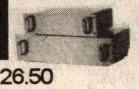
It provides 3 input jack pairs. One pair accept a high impedance microphone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20Hz-20KHz. THD:<0.1%. Input Sensitivity :Mic /Guitar 10mV, Hi 380mV, Lo 640mV.Ready to plug in when assembled.

30W + 30W Pre & Main Stereo Amplifier TA-323A (1 lb.) ▲

29.25
Kit: $ ~~32.50~~ Asmb.$ 50.50

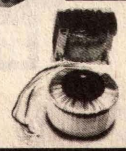
Power Output: 30W into 8 ohms RMS per channel. THD: < 0.1% from 100 HZ to 10 KHZ. Sensitivity: Phono 3mV @ 47K. Tuner, Tape 130mV @47K. Signal to Noise ratio: 80dB. Power Requirement: 22 to 36V AC, 3A. May use Mark V Model 002 Transformer. Suggested Cabinet LG-1684.

Metal Cabinets Aluminum Front Panel



LG-1273	3x12x7"	(4 lbs.)$	26.50
LG-1684	4x16x8"	(7 lbs.)	32.50
LG-1924	4x19x11½"	(10 lbs.)	38.25
LG-1925	5x19x11½"	(10 lbs.)	42.00
LG-1983	2¼x19x8"	(7 lbs.)	35.25
LG-1927	7x19x11½"	(15 lbs.)	52.50

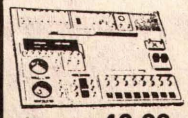
Transformers (5-12 lbs.) **Toroidal Transformers



# 001	28V/30V x2	6A	$ 30.00
# 002	36V x2	3A	25.00
# 003	40V x2	6A	32.00
# 008**	28V/30V x2	6A	42.00
# 009**	48/53V x2	8A	68.00
# 012**	33/40/42V x2	6A	52.00

300-in-one Electronic Lab Kit ▲▲

Best Buy



$ ~~59.99~~ 49.99

Learn about transistors, capacitors & electronic circuits. Build electronic games, battery checker & more. It even includes a breadboard for adding your own components. Complete with easy-to-follow manuel. Requires 6 "AA" batteries. (6 lbs.)

Minimum order: $ 20.00. We accept Visa, MasterCard, Money Orders, and Checks(allow 2 weeks for clearance). We ship by UPS ground inside US (min $6.00) and ship by US mail outside US. Please call our operator for orders over 2 lbs. or foreign orders.

CIRCLE 325 ON FREE INFORMATION CARD

CIRCLE 270 ON FREE INFORMATION CARD

EARN MORE MONEY!

Be an FCC LICENSED ELECTRONIC TECHNICIAN!

No costly school. No commuting to class. The Original Home-Study course prepares you for the "FCC Commercial Radiotelephone License." This valuable license is your professional "ticket" to thousands of exciting jobs in Communications, Radio-TV, Microwave, Maritime, Radar, Avionics and more...even start your own business! You don't need a college degree to qualify, but you do need an FCC License.

No Need to Quit Your Job or Go To School

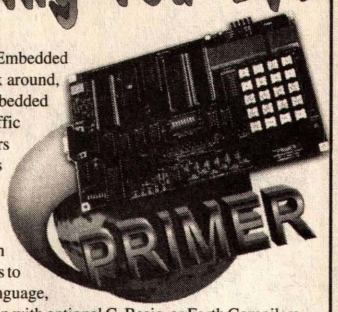
This proven course is easy, fast and low cost! GUARANTEED PASS—You get your FCC License or money refunded. **Send for FREE facts now. MAIL COUPON TODAY!**

Or, Call 1-800-932-4268 Ext. 210

COMMAND PRODUCTIONS
FCC LICENSE TRAINING, Dept. 210
P.O. Box 2824, San Francisco, CA 94126
Please rush FREE details immediately!

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

World Passing You By?



Are you interested in Microprocessors & Embedded Control Systems? If not you should be! Look around, just about everything these days has an embedded microprocessor in it. TVs, cars, radios, traffic lights & even toys have embedded computers controlling their actions. The Primer Trainer is the tool that can not only teach you how these devices operate but give you the opportunity to program these types of systems yourself. Examples & exercises in the Self Instruction manual take you from writing simple programs to controlling motors. Start out in Machine language, then move on to Assembler, & then continue on with optional C, Basic, or Forth Compilers. So don't be left behind; this is information you need to know!

Examples Include:

- **Measuring Temperature**
- **Using a Photocell to Detect Light Levels**
- **Making a Waveform Generator**
- **Constructing a Capacitance Meter**
- **Motor Speed Control Using Back EMF**
- **Interfacing and Controlling Stepper Motors**
- **Scanning Keypads and Writing to LCD/LED Displays**
- **Bus Interfacing an 8255 PPI**
- **Using the Primer as an EPROM Programmer**
- **DTMF Autodialer & Remote Controller (New!)**

The PRIMER is only $119.95 in kit form. The PRIMER Assembled & Tested is $169.95. This trainer can be used stand alone via the keypad and display or connected to a PC with the optional upgrade ($49.95). The Upgrade includes: an RS232 serial port & cable, 32K of battery backed RAM, & Assembler/Terminal software. Please add $5.00 for shipping within the U.S. Picture shown with upgrade option and optional heavy-duty keypad ($29.95) installed. Satisfaction guaranteed.

EMAC, inc.

11 EMAC WAY, CARBONDALE, IL 62901
618-529-4525 Fax 457-0110 BBS 529-5708
World Wide Web: http://www.emacinc.com

1985 - 1998
OVER *12* YEARS OF SERVICE

RF Data Modules

AM Transmitter

- Sub Miniature module
- SAW Controlled
- No adjustable components
- Low current - 2.5mA
- Supply 2.5-12Vdc
- 418MHz or 433MHz
- Range up to 300ft
- CMOS/TTL data input
- 7 x 11 x 4mm !

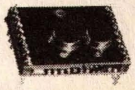
AM-TX1-xxx $12.60

AM Receiver

- Compact Hybrid Module
- Very stable
- CMOS/TTL output
- Patented Laser Trimmed
- 5Vdc, 0.8mA (HRR6)
- 2kHz data rate
- Sensitivity -105dBm
- 38 x 12 x 2 mm

AM-HRR6-xxx... $16.33

FM Transceiver



- Only 23 x 33 x 11mm
- Up to 40,000bps data rate
- Up to 450ft. range.
- 5V operation
- 418MHz or 433MHz FM
- 5V CMOS logic interface
- Fast 1mS enable
- Power saving feature
- Carrier Detect output

BiM-xxx-F $87.36

RS232 Transceiver

- 3wire RS232 interface
- 19.2Kbps half duplex
- 418MHz or 433MHz FM
- 7.5-15Vdc, 20mA
- TX/RX Status LED's
- Up to 400ft. range
- 1/4 wave ant. on board
- User data packetizing
- 58 x 40 x 15mm

CYPHERNET $139.30

AM Transmitter

- Range up to 250ft.
- SAW controlled stability
- Wide supply range 2-14V
- CMOS/TTL input
- Low current. 4mA typ.
- Up to 4kHz data rate
- Small: 17 x 11mm

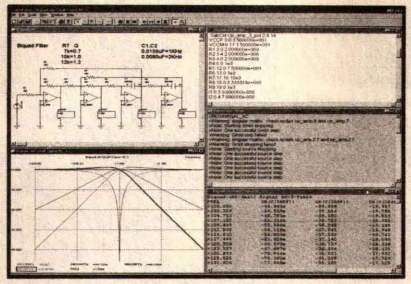
AM-RT5-xxx $12.10

ABACOM TECHNOLOGIES

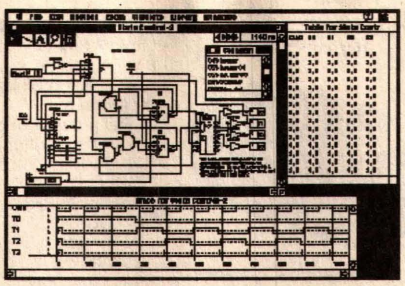
Free Catalog

call: (416)236 3856
fax: (416)236 8866
www.abacom-tech.com
MasterCard / VISA

CIRCUIT DESIGN FOR WINDOWS AND MACINTOSH



B² SPICE



B² LOGIC

B² SPICE and B² LOGIC are the best values in circuit simulation tools. They are used at over 100 major universities and many leading Fortune 500 companies including the University of Michigan, Stanford, AT&T, General Electric, and Motorola.

B2 Logic provides precise and customizable timing of individual pins on each device. No other program in this price range will help you catch as many timing glitches and violations. It also supports busses and subcircuits to facilitate the design of complex circuits.

B2 Spice integrates an intuitive interface with an optimized Spice engine. With a library of over 3000 parts, you will be able to find the part you need. In case you don't find it, you can easily import new parts into the libraries. The interface supports the full set of Spice3F5 simulations as well as Temperature and Parameter sweeps.

Beige Bag Software
279 E. Liberty
Ann Arbor • Michigan • 48104

Phone 734.332.0487
Fax 734.332.0392
E-Mail info@beigebag.com
Internet www.beigebag.com

B² SPICE $249

- Simulations: DC, Parameter, Dual,and Frequency Sweeps, Transient, Noise, Fourier, Transfer Functions, Pole-Zero, Distortion
- Spice 3F5 (32-bit)
- Over 3000 devices
- Over 30 parameterized devices
- Powerful graph interface
- Device and model parameter dialogs
- Run simulations directly from netlists

B² LOGIC $179

- Subcircuits and subcircuit probing
- Precise customizable pin timing
- Over 100 components available
- Define new devices with equations and tables including state variables

ELECTRONIC DESIGN PACKAGE $279

- Includes B² SPICE and B² LOGIC

- Demo Disks Available
- University & Student Prices Available
- Site Licenses Available
- Dealer Inquiries Welcome
- Visa/MasterCard Accepted

CIRCLE 337 ON FREE INFORMATION CARD

CONTROL
RELAYS • LIGHTS • MOTORS

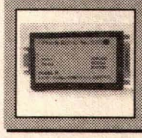
MEASURE
TEMPERATURE • PRESSURE • LIGHT LEVELS • HUMIDITY

INPUT
SWITCH POSITIONS • THERMOSTATS • LIQUID LEVELS

MODEL 30 ..... $79

- PLUGS INTO PC BUS
- 24 LINES DIGITAL I/O
- 8 CHANNEL-8 BIT A/D/ IN
- 12 BIT COUNTER
- UP TO 14K SMP/SEC

MODEL 45 ..... $189



- RS-232 INTERFACE
- 8 DIGITAL I/O
- 8 ANALOG INPUTS
- 2 ANALOG OUTPUTS
- 2 COUNTERS-24 BIT

MODEL 100 ..... $279

- 12 BIT 100 KHZ A/D
- 4 ANALOG OUTPUTS
- 3 TIMER COUNTERS
- 24 DIGITAL I/O

MODEL 150-02 .... $179

- RS-232 INTERFACE
- TRMS, 20 AMPS
- 12 BIT A/D
- OPTO-ISOLATED
- COMPLETE DMM

MODEL 40 ..... $99

- RS-232 INTERFACE
- 28 LINES DIGITAL I/O
- 8 ANALOG INPUTS
- PWM OUTPUT

MODEL 70 ..... $239

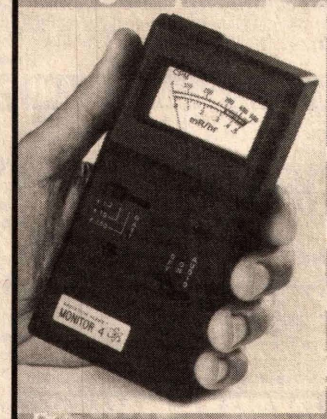
- RS-232 INTERFACE
- 18 BIT A/D
- 5.5 DIGIT
- UP TO 60 SMP/SEC

Prairie Digital, Inc.
PHONE 608-643-8599 • FAX 608-643-6754
846 SEVENTEENTH STREET • PRAIRIE DU SAC, WISCONSIN 53578

CIRCLE 215 ON FREE INFORMATION CARD

RADIATION® A•L•E•R•T
QUALITY AT YOUR FINGERTIPS

The easy to build Monitor 4 kit is a cost effective way for you to survey for radiation



BUILD OR BUY YOUR OWN GEIGER COUNTER

The finished kit is a sturdy general purpose Geiger counter capable of detecting alpha, beta, gamma, and x-rays. Kit price $160.00

S.E. INTERNATIONAL

S.E. International, Inc.
P.O. Box 39
Summertown, TN 38483-0039
Tel: 800-293-5759 Fax:931-964-3564
E-mail: seiinc@usit.net Website: seintl.com

WIRELESS VIDEO CAMERAS

Wireless 4-Channel B/W & COLOR Cameras Available!
Plug and Play Readiness

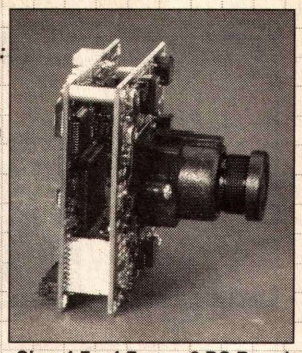
GFT-1001 $189.95
Gives any camera the ability to be Wireless.
Transmits Over 1000 ft.

Wireless Observations System's
GFS-1001 (900MHz) -*$499.95*
GFS-1001c (900MHz) -*$599.95*
(1.2 Ghz system's available)

COLOR BOARD CAMERAS

Micro Color MB-960c Key Features:
- Lens: 3.6mm F=2
- Full Digital Process of BLC
- Auto Tracing White Balance
- 2H Mode of H.V. Aperture correction
- Digital process of color matrix
- Electronic Shutter up to 1/ 10,000
- *Dip Switch Adjustment settings:
  - 6-BLC
  - 5-Auto Shutter
  - 4-AGC/On
  - 3-Flickless
  - 2-AWB/On
  - 1-No function

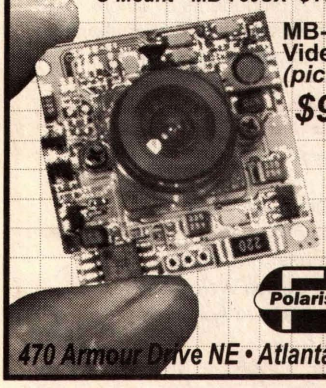
MB-960c
$199.95



Size: 1.7 x 1.7 sq. x 2 PC Board

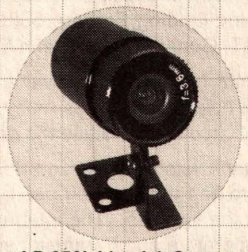
MB-750 SERIES BOARD CAMERAS

Pinhole • MB-750p -$89.95
C-Mount • MB-750UX -$119.95



MB-750U
Video Camera
(pictured)
$99.95

ODH-106
Board Camera Housing
4.5 x 2.75 x 2.75", High-Impact, Weatherproof, w/ 5.5" Arm.



LP-850i Lipstick Camera
$129.95

NIGHT VISION

Other Models Available to Choose From!

Night Vision Scope w/ Illuminator
Fun to use, Low cost.
3.6 x 85mm f1.6
MI-PR100 - $399.95

FREE Polaris Product Catalogs

Polaris Industries
http://www.polarisusa.com
800.752.3571

470 Armour Drive NE • Atlanta GA 30324 • Tech Info: 404-872-0722 • FAX 404-872-1038

CIRCLE 220 ON FREE INFORMATION CARD

HACKING THE INTERNET

The latest tricks and methods being used on the Net to pirate software (warez) and the newest hacking websites. Includes examples, countermeasures, password defeats, UNIX, Sprintnet, brute force techs, lots of tips. *More! $29.*

INTERNET TRACKING & TRACING: Scammers, spammers, stalkers, infectors, and others hide behind the Internet's anonymity to commit serious offenses. Learn from master hackers best methods to track & trace IDs and origins, and to protect your own privacy. *More! $29.*

INTERNET CONS & SCAMS: Internet cons, scams and related frauds now rake in $2+Billion annually! Most are done anonymously with impunity. Details how they're done, how to ID them, how to protect yourself. *More! $25.*

THE COOKIE TERMINATOR: When online, many websites track your every move! Browser cookie, history and cache files contain personal data readily accessible to Internet predators, scammers, spammers and snoops. Your financial, medical, political, habits, lifestyle, future plans data is exposed to the world! Step-by-step how to remove and stop cookies from destroying your privacy. *$25.*

Any 2 for $49, 3 for $64, all 4 for $79!

PBX HACKING

PBXs hacking losses are at $5-$10 Billion annually! Details how PBXs are hacked, countermeasures. Author interview in Forbes! $24.

CELLPHONE MODIF. GUIDE

How cellphones operate and are modified. Vulnerabilities to hack attack and countermeasures. Cloning details for NAMs, ESNs, etc, control data formats, computing encoded MINs, ESNs, SIDHs, Op Sys, PROMs, forcing ACK, test mode and resets, cable diagrams, scanning, tracking, scanner restorations, freq allocations, roaming, step-by-step to keypad-reprogram 100+ popular cellphones. One FREE database search. *More! $49.*

PAGER (BEEPER) MANUAL: How Pagers work, different types and uses, freqs, advantages over and uses with cellphones, and tips and tricks. How Pagers are hacked/countermeasures. And plans for a Personal Pocket Paging System (xmitter and receiver). *More! $29.*

Both for only $69!

PHREAKING CALLER ID & ANI

How they work and dozens of ways of defeating Caller ID, ANI, *69, *57, Call Blocking, *67 etc. Describes ESS, SS7, CN/A, CAMA, DNR, Diverters, Centrex - *more! $25.*

HACKING FAX MACHINES

Details all known methods of hacking Faxes and countermeasures. Includes computer fax modems, crimes, interceptions, fax servers, fax-on-demand, protocols, parameters, compression, encryption, and fax surveillance-type mods. *More! $29.*

VOICE MAIL HACKING

VMSs are hacked to penetrate PBXs to make outgoing calls, get free VMB usage, secretly read/change/delete messages, or damage the VMS (or its PBX) itself. Step-by-step on how it's done, countermeasures. $29.

STOPPING POWER METERS

As reported on "60 MINUTES"! New 6th Edition! Plans for devices that can slow down (even stop) watt-hour meters - while loads draw full power! Devices plug into one outlet and normal loads into other outlets. Describes meter creep, overload droop, pole meters, etc. *$29.*

SPM THE VIDEO: Now its easier to learn about KW-HR Power Meters than ever before! This educational video shows you how they work and their anatomy. Demonstrates SPMEM device and external magnetic methods used to slow and stop meters! Hosted by a top expert in the field. From the novice to the pro, an excellent source of info on these exciting devices! Great in combo with our SPM related manuals! $29.

THE I.G. MANUAL: External magnetic ways (applied to meter) to slow down and stop power meters while drawing full loads. Plans *$25.*

KW-HR METERS: How watt-hour meters work, calibration, error modes (many), ANSI Standards, etc. Demand and Polyphase Meters. Experimental results to slow and stop meters by others. *$25.*

Any 2 for $49, 3 for $64, all 4 for $79!

COMPUTER PHREAKING

Describes in detail how computers penetrate each other, and how VIRUSES, TROJAN HORSES, WORMS are implemented. Dozens of computer crime and abuse methods and countermeasures. Includes disk filled with hacker text files and utilities, and the legendary FLUSHOT+ protection system. Internet advice, password defeats, glossary - *much more!* Manual + PC Disk! *$39.*

THE HACKER FILES: 3 HD PC disks filled with choice raw, colorful and highly informative hacker, phreaker text files covering many topics! *$39.*

Both for only $69!

BEYOND VAN ECK PHREAKING

Plans for remote eavesdropping of TV video signals. Range up to 1 KM. Describes how van Eck systems work, and are also used in surveillance of computer systems. $29. The van Eck Demo Tape is $29. Both for only $49!

MANY MORE TITLES!

Beyond Phone Color Boxes - $29
Hacking Answer. Machines - $19
Casino Hacking - $25
Automatic Teller Machines - $39
Credit Card Scams - $29
Cons & Scams - $29
Social Engineering - $29
Polygraph Defeats - $25
By an Order of the Magnitude - $49
Ultimate Success Manual - $19
Stealth Technology - $19
Secret & Survival Radio - $19
High Voltage Devices - $29
Mind Control - $29
Under Attack! - $29
Radionics Manual - $29
Heal Thyself - $19
Secrets of Solderless BBs - $24
Secret & Alternate IDs - $15
Cryptanalysis Techniques - $29
Government Land Grab - $15
Rocket's Red Glare - $29
Survival Guns & Ammo - $19
The Ultimate Driver - $19

THE DIRTY-2 DOZEN!

24+ *Hot* Hack/Phreak Disks!
See **CATALOG!**

SPECIAL PROJECTS

We will design & build just about anything electronic! Hardware done as SPECIAL PROJECTS only. See Catalog for details and SP Application Form, else: www.tsc-global.com/spaf-spp.html

TOP SECRET

CONSUMERTRONICS

2430 Juan Tabo, NE, #259, ABQ, NM 87112
P.O. Box 23097 ABQ, NM 87192
Fax: 505-292-4078 (all hours, orders only) Voice: 505-237-2073 (10-6 M-F)

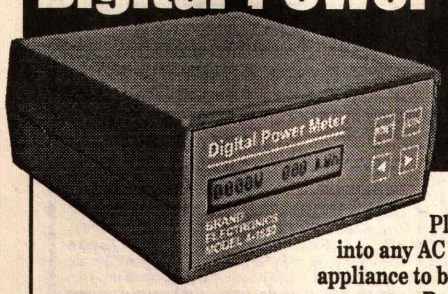
Full Catalog: www.tsc-global.com/consumer.html Adventure: www.tsc-global.com

Established in 1971. Featured on CBS "60 Minutes," Forbes, New York Times. Add $5 total S/H (US, Canada). Postal MO is fastest! VISA, MC OK. No CODs. Take 10% OFF all Orders over $100, and Take $2.00 OFF all New Orders over $20 placed by Mail or Fax. Catalog $1 w/order, $3 w/o.

Sold for legal educational purposes only. See Catalog for LIMITED WARRANTY, SPECIAL PROJECTS and all other applicable policies.

CIRCLE 226 ON FREE INFORMATION CARD

Digital Power Meter



Measures
Watts
& Watt-hours
(kW-hr)

Simple to use.
Plug the Power Meter into any AC outlet, and plug the appliance to be measured into the Power Meter. That's it!

Model 4-1850:

- Measure REAL ("true") power 1 to 1850 Watts
- Measure Power used, 1 Watt-hour to 9999 kilo-Watt-hr
- Measure power cost ($), just enter cost per kilo-Watt-hr

New! Advanced model with additional features Irms, Vrms, Power Factor, 20 mhz processor amd more!
Model 20-1850

Performs the same functions as instruments costing $500-$1000!
No other instrument on the market even comes close for this price!!

Model 4-1850 Only $149.95 Delivered!
Model 20-1850 Only $249.95 MC/Visa/MO/Check

Custom applications available • Dealer inquires welcome

Brand Electronics,
421 Hilton Rd.
Whitefield, ME 04353
For information only, call 1-207-549-3401

Call today! To order, call toll free, 24 Hrs.
1-888-433-6600
http://www.mint.net/~ebrand/

PIC'n Books

LEARN ABOUT PIC16/17 MICROCONTROLLERS

EASY PIC'n
Beginner

- Programming techniques
  - Instruction set
  - Addressing modes
  - Bit manipulation
  - Subroutines
  - Sequencing
  - Lookup tables
  - Interrupts
- Using a text editor - source code
- Using an assembler
- Timing and counting
- Interfacing - I/O conversion
- Lots of examples

$29.95

PIC'n Up The Pace
Intermediate

- Serial communication
  - PIC16 to peripheral chips
  - PIC16 to PIC16
- Serial EEPROMS
- LCD interface
- Scanning keypads
- D/A conversion
- Sensors - analog voltage output
- A/D conversion
- Math routines
- Decimal interface
- PIC16F84 EEPROM data memory
- Lots of circuits and code

$34.95

+ $4 s/h in US for one book, $5 both books
VISA, MC, AMEX, MO, Check
CA residents please add 7.25% CA sales tax
PIC is a trademark of Microchip Technology Inc.

SQUARE 1 ELECTRONICS

P.O. Box 501, Kelseyville, CA 95451
Voice (707) 279-8881 FAX (707) 279-8883
Web Site: http://www.sq-1.com
E-Mail sqone@pacific.net

LIQUIDATING WAY Below Cost

All 6 pcs $25!

10 lbs

Shop the way the Pro's do
Use Their Tools !

Find: Distributors, Manufacturers and Service providers for **Products, Services or ANY Component Parts imaginable from USA & Canada.** Sources for Everything from Gears to Semiconductors to Foreign Assembly Services. Find Products by Description or find ANY Company in the Electronics Industry. Consists of (2 vol) Chilton's EITD, (3 vol) Springs Technical's EPGD & (1 cd) American Business CD.

$25 ALL 6 Pcs Current Back issues
$55 98 Single Edition EITD (Chilton)
$117 98 3 Edition EPGD (Springs Tech)
$120 98 American Buss CD

as Low as $49!

10 lbs

BIBLE of the IC INDUSTRY

The Best IC Reference Published. Nothing Else like it in the World! 100,000 ICs of EVERY KIND & Every Manufacturer. Specifications, Selected Data Sheets, Every known Cross-reference, Alternate Sources, Manufacturer Profiles & Distributors. Perfect for Sales, Service, Engineering & Experimenters.

$49 3 Vol Back Issue of Current Production ICs Perfect for Service & Moderate Design Work
$55 *Above if Purchased Alone*

$109 ~~$195~~ 97 Books, For Advanced Design
$129 ~~$235~~ 97 CD Rom
$185 ~~$195~~ 98 Books
$199 ~~$235~~ 98 CD Rom
other editions may be available

Service Center Favorite
SEMICONDUCTOR CROSS REFERENCE & SPEC

as low as $79! with any other item

Quarter Million Transistors, ICs & Diodes with REFEREE

A Specialist in "Hard to Cross House Numbers"
Easy, Powerful & Fast. *The Most Comprehensive Software Sold.* ***A selection yields Device Specifications & 75 to 250 Potential Replacements !***

Replacement Numbers are Totally Global including Domestic, Asian, European, House Branded, as well as ECG, NTE, SK & GE. Displays Case Drawings, Lead Configuration & Pin-outs for many Devices. Coverage of Replacement Numbers is Very Impressive. 7 Disk Set (17 Meg decompressed) For DOS, Win3.1 & 95 Latest Version 7.11 Includes Many Helpful Conversion Utilities, Tables & Formulas.

Includes: 4 HUGE Consumer Electronics Industry Directories
1- Consumer Electronics Parts Sources (Service) 2- Consumer Electronics Manufacturers
3- The Entire Computer Industry 4- Semiconductor Manufacturers
Perfect for Service, Engineering and Purchasing.

EEM ***Largest Component Parts Directory*** available. All the Major Parts Manufacturers display Entire Product Line Catalogs with Pictures & Data sheets. Cabinets, Transformers, Pots, Semi's, Resistors, Capacitors, Crystals, Coils, Connectors, Wire, Heat sinks, Switches, Fuses, Speakers, Displays, an Endless list ! Makes parts sourcing a snap. The 4 Volume (18 Lb) EEM Set shown is available on CD ROM ONLY.

(back issues may be available)

Bonus ***Largest Phone Directory Made***

till Oct 31

CHILLING Power *What a Deal !*

Business, 14 Million!
FREE! *with any item* *alone* $29 ~~$89~~

Bus, Municipal, & Residential
FREE! *with REFEREE & ICM* *alone* $39 ~~$219~~

All Cards & COD we don't sell semiconductors Sorry, NO catalog **10-9 EST**
Netcom 800-733-3733 ext 6300 FAX 516-826-7776 7 Days

CIRCLE 219 ON FREE INFORMATION CARD

2539 W. 237th Street, Bldg. F, Torrance, CA 90505
Order desk only: USA: (800) 872-8878 CA: (800) 223-9977
L.A. & Technical Info: (310) 784-5488 Fax: (310) 784-7590
OEM INQUIRIES WELCOME

TIMELINE INC.

Over 12 years and 30,000 customers and still growing

Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

LIQUID CRYSTAL DISPLAYS

240x64 dot LCD with built-in controller.

AND 4021ST-EO. *Unit is EL back-lit.* $59.00 or 2 for $109.00 *or*
OPTREX. DMF5005 *(non back-lit)* $49.00 or 2 for $89.00
20 character x 8 line 7¼L x 2½H *The built-in controller allows you to do text and graphics.*

Alphanumeric—parallel interface

16x1	$7.00	20x2	$10.00	32x2	$8.00
16x1 (lg. char.)	$10.00	20x4	$15.00	40x1	$8.00
16x2	$7.00	20x4 (lg. char.)	$10.00	40x2	2 for $20.00
16x2 (lg. char.)	$10.00	24x2	$10.00	40x4	$20.00
16x4	$15.00	32x4	$10.00	4x2	$5.00

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • ***Certain models are backlit, call for more info.***

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$25.00	480x128	Hitachi	$10.00
640x400 (backlit)	Panasonic	$20.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$25.00**

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $25.00 • 7 inch Amber $25.00
9 inch Amber or Green $25.00

5" COLOR MONITOR $39.00

2 for $69.00

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • *Mfr. Samtron*

9" COLOR SVGA MONITOR $249.00 Fully Enclosed – Tilt and swivel type.

POS & BAR CODE

MAGNETIC CARD READER $25.00

Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.
HP bar code wand (HBCS 2300) $25.00

HACKER CORNER

EMBEDDED 486 COMPUTER $99.00

Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible

Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

SONY Miniature Color LCD Display (LCX005BKB) $29.00

• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

CELL SITE TRANSCEIVER $49.00 2 for $99.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

LASER PRODUCTS

HeNe Laser Head (10Mw max. output) TEMOO, 15.5" long MFG: NEC **$89.00**
Laser Power Supply (for HeNe tube) **$79.00**

LASER SCANNER ASSEMBLY $19.00

Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator **$20.00**

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**
Index guided. Threshold current 40 ma typical.

3 and 4mW, 1,300nm LASER DIODES, 5.6mm package, $15.00
Mitsubishi Electric part number ML701BIR-E21A, General specs are:
1. Vop=1.25, Beam Divergence 25.6° x 28.6°; 2. Tc=24°C, Iop=19 to 20mA, ITH=10.7mA; 3. Wavelength range between 1,280nm and 1,330 nm

POLYGON MOTOR UNIT & DRIVER $69.00

Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

CIRCLE 275 ON FREE INFORMATION CARD

❖ ATTENTION CABLE VIEWERS ❖

CABLE VIEWERS. . .get back to your BASIC Cable Needs

Call 800-577-8775

For information regarding all of your BASIC cable needs.

5 GOOD REASONS TO BUY OUR FAR SUPERIOR PRODUCT

- ❖ PRICE
- ❖ EFFICIENT SALES AND SERVICE
- ❖ WE SPECIALIZE IN 5, 10 LOT PRICING
- ❖ ALL FUNCTIONS (COMPATIBLE WITH ALL MAJOR BRANDS)
- ❖ **ANY SIZE** ORDER FILLED WITH SAME DAY SHIPPING

We handle NEW equipment ONLY – Don't trust last year's OBSOLETE and UNSOLD stock!
COMPETITIVE PRICING—DEALERS WELCOME

HOURS: Monday-Saturday 9-5 C.S.T.

It is not the intent of B.E.S.W. to defraud any pay television operator an we will not assist any company or individual in doing the same.
*Refer to sales personnel for specifications.

BASIC ELECTRICAL SUPPLY & WAREHOUSING CORPORATION

P.O. Box 8180 ■ Bartlett, IL 60103 ■ 800-577-8775

CIRCLE 313 ON FREE INFORMATION CARD

ONLY COOL-AMP SILVERPLATES ON THE JOB.

From a customer testimonial:

"Ok, your edge connectors don't connect. Or you want to plate your own PC creations, but you don't want to bother with electro-plate solutions. The plating on the socket...has worn off and no longer makes reliable contact...what are you going to do now?

"Give the people at Cool-Amp a call. They have a silver plating compound I have used for the past couple of years that solves all of the above problems and more. This white powder has an infinite shelf life...and is easy to use.

"It will actually put a permanent silver plate on copper, brass or bronze...There are no messy or dangerous chemicals. Application could not be easier. Use a clean rag and a little bit of water and just rub it on a clean surface. In minutes you can permanently silver plate a circuit board or replate a power amp tube or socket.

"It has saved me time, money and my sanity."

Cool amp has even outperformed electroplating in recent tests. It is time-proven since 1944.

COOL-AMP

AND CONDUCTO-LUBE. *THE* SILVER-BASED CONDUCTIVE LUBRICANT.

The upstart, since 1952. Developed for switches, uses continue to expand to all applications needing a conductive lubricant.

Conducto-Lube

ORDER FACTORY DIRECT:

503-624-6426 or FAX 503-624-6436

http://www.thomasregister.com/cool-amp

CIRCLE 228 ON FREE INFORMATION CARD

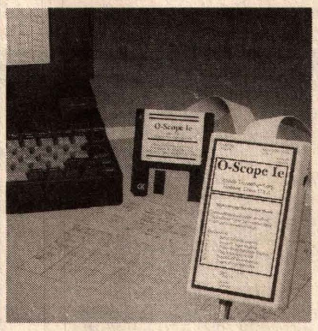
DIGITAL STORAGE

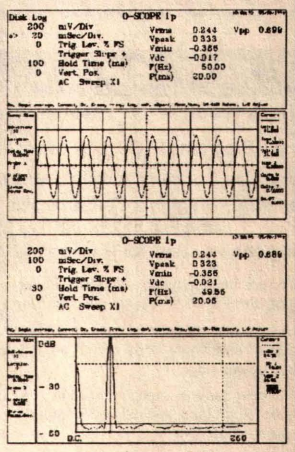
OSCILLOSCOPES

WITH SPECTRUM ANALYZER, DVM, FREQ. COUNTER, AND DATA LOGGER.

from **$189.**

PORTABLE MODULES CONVERT PC'S INTO MULTIPURPOSE TEST AND MEASURING INSTRUMENTS.





Why lug a scope around? Toss one of our modules into your laptop case or tool kit. For a multi-purpose test device, plug to a PC parallel port and use the PC screen. Continuous, delayed, or triggered sweeps can be frozen on the screen, printed out, or saved to disk. Frequency Spectrums DC to 25 MHz.

Allison now provides PICO TECHNOLOGY Ltd. portable test equipment, including high-speed scopes, and multi channel data loggers. Pico and O-Scope modules accept standard probes and work with 286 or faster PC's.

FEATURES:

- PORTABLE UNITS TO 25 MHz
- USES PRINTER PORT
- USES STD. PROBES

OPTIONS:

- PROBE SETS
- AUTOMOTIVE PROBES
- BATTERY PACKS
- SOFT & HARD CASES

O-Scopes Made in U.S.A. **Picos Made in U.K.**

Same Day Shipping
Includes Cable, Software & Manuals

O-Scope Ip (DC-50KHz, single trace) ..... $189.
O-Scope II (DC-500KHz, dual trace) ..... $349.
PICO (ADC 200/20) (DC-10MHz, dual trace) ..... CALL
PICO (ADC 200/50) (DC-25MHz, dual trace) ..... CALL

PICO pc based data loggers from $99.

Shipping within U.S. UPS Ground $7.50(Second day $11.50)

SEND CREDIT CARD INFO., M.O., or CHECK,OR CALL

1-800-980-9806

Allison Technology Corporation

2006 FINNEY-VALLET, ROSENBERG, TX 77471
PHONE: 281-239-8500 FAX: 281-239-8006

http://www.atcweb.com

Interactive catalog:www.tekview.com

TV cable CONVERTERS & EQUIPMENT

* 30 days money back guarantee
* 1 yr warranty
* Quantity Discounts
* Dealers Welcome!

VISA MC AMEX C.O.D.

NYE Electronics

(800)739-2253

EZ-EP DEVICE PROGRAMMER - $169.95

Check Web!! -- www.m2l.com

Fast - Programs 27C010 in 23 seconds

Portable - Connects to PC Parallel Port

Versatile - Programs 2716-080 plus EE and Flash (28F,29C) to 32 pins

Inexpensive - Best for less than $200

- Correct implementation of manufacturer algorithms for fast, reliable programming.
- Easy to use menu based software has binary editor, read, verify, copy, etc. Free updates via bbs or web page.
- Full over current detection on all device power supplies protects against bad chips and reverse insertion.
- Broad support for additional devices using adapters listed below.

Available Adapters

EP-PIC (16C5x,61,62x,71,84)	$49.95
EP-PIC64 (62-5,72-4)	$39.95
EP-PIC12 (12C50x)	$39.95
EP-PIC17 (17C4x)	$49.95
EP-51(8751,C51)	$39.95
EP-11E (68HC11 E/A)	$59.95
EP-11D (68HC711D3)	$39.95
EP-16 (16bit 40pin EPROMS)	$49.95
EP-Z8(Z86E02,3,4,6,7,8)	$39.95
EP-SEE2 (93x,24x,25x,85x)	$39.95
EP-750 (87C750,1,2)	$59.95
EP-PEEL(ICT22v10,18v8)	$59.95
EP-1051(89C1051,2051)	$39.95
EP-PLCC (PLCC EPROMs)	$49.95
EP-SOIC (SOIC EPROMs)	$49.95

Many Other Adapters Available

M²L Electronics

970/259-0555 Fax: 970/259-0777

361 S Camino Del Rio Suite #119; Durango, CO 81301; CO orders add 7% sales tax.

http://www.m2l.com

ELECTRONIC COMPONENTS

Visit our web site!
www.mouser.com

FREE catalog is available on the internet, CD-ROM, or in paper!

- Over 72,500 Products
- More than 145 Suppliers
- Same Day Shipping
- No Minimum Order

800-992-9943

817-483-6828 Fax: 817-483-6899
catalog@mouser.com

958 North Main St., Mansfield, TX 76063

CIRCLE 318 ON FREE INFORMATION CARD

Quality Microwave TV Systems

WIRELESS CABLE - IFTS - MMDS
ATV - INTERNATIONAL - DIGITAL

Amplifiers • Antennas • Books • Components
• RF Frequency 2100-2700 MHz
• SASE For ***"FREE"*** Catalog or Send $1

PHILLIPS-TECH ELECTRONICS

P.O. Box 13074 • Scottsdale, AZ 85267-3074
CATALOG/INFO: 602-947-7700
ORDER LINE: 800-880-MMDS
FAX LINE: 602-947-7799
WEBSITE: www.phillips-tech.com
E-MAIL: product@phillips-tech.com

Visa • M/C • AmEx • Discovery • COD's • Quantity Pricing

CHALLENGER SYSTEM
31-Channel Complete $240
Other Systems Available
5 Year Warranty
FREE SHIPPING

VIDEO SYNC GENERATOR

Restores Horizontal and Vertical Sync Lines from Distorted Video

Lost Sync

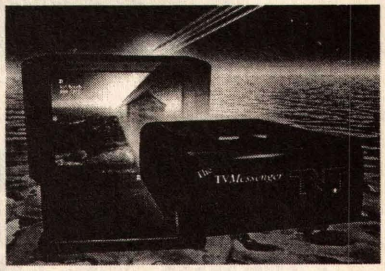
Restored Sync with VSG

For Free Information Package and Pricing

VISA Call (219) 233-3053 MasterCard
www.south-bend.net/rcd

R.C. Distributing, PO Box 552, South Bend, IN 46624

TVMessenger
Caller ID for TV!



TV*Messenger* provides:

- Convenience
- Uninterrupted TV viewing
- Callers' log
- Visual call indicator
- Ease of use
- Security

Not available In stores!

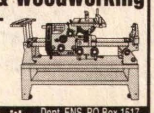
Only $89.95

Arrow Technologies
13341 A St., Omaha, NE 68144
1-888-554-2776

ULTIMATE HOME SHOP

Complete tools for metal & woodworking

Starting at **$995** — Smithy —
Easy to use
Versatile
Affordable
FREE CATALOG



Call 1-800-345-6342 or write: Smithy Dept. ENS, PO Box 1517, Ann Arbor, MI 48106-1517

CABLE TV CONVERTERS

Equipment & Accessories
Wholesalers Welcome

Call C&D ELECTRONICS
1-888-615-5757 M-F 10a-6p

FCC License Preparation

Electronics Tech., Avionics, Marine & Radar
HOMESTUDY—Fast, Easy & Inexpensive
Manuals, Audio, Video, PC disks, latest Q&As
Free 1-800-800-7555 "Guaranteed Pass"
See at http://www . worldaccessnet.com
BusinessShowcase/wpt. 4701 NE 47th St.
Vancouver, WA 98661 – WPT Publications

SURVEILLANCE HIDDEN CAMERAS
DIRECT FROM MANUFACTURER–BEST PRICE IN THE MARKET

Ultra miniature hidden camera, in dome, smoke or motion detector w/ mic. B/W or Color. Wide view angle. Low light sensitivity + super sharp images, plus video and audio output. From $159.00. Also 1/3" B/W board Cameras w/mic, starts at $79.00 USD. Wireless hidden camera, start at only $249.00 USD. Plus $5.95 for S/H. Whole/Retail Welcome. COD, Check, Money Order or Visa/MC.

BOLIDE INTERNATIONAL CORPORATION
PH: (800) 355-0895 or (626) 575-8178
9660 Flair Drive #218, El Monte, CA 91731
http://www.bolideamazingproducts.com/

!!!BROADCAST FARTHER!!!

The model 220 is an 80-110 MHz RF amplifier that connects to mono or stereo FM transmitters and produces a *powerful* 2-15 watt signal which could broadcast up to 5 miles or more! Requires 50-150 mW drive.

Step by step plans complete with part source information and antenna designs . . . ONLY **$14** PLUS $2 S&H NO C.O.D.s

Progressive Concepts
BOX 586 STREAMWOOD, IL 60107
(630)736-9822 FAX:(630)736-0353
VISA MasterCard

POPTRONIX®

Awaiting your call! Online Edition

http://www.poptronix.com

Any waveform you want!

Starting at

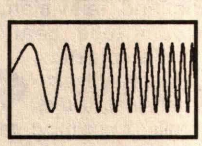
$795

Quantity 1

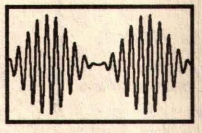
Money back guarantee

- **Synthesized Signal Generator**
  Clean sinewaves DC-20 MHz with .001% accuracy! .1 Hz steps. DC Offset. RS232 remote control.
- **Arbitrary Waveform Generator**
  40 Megasamples/Second. 32,768 points. 12 bit DAC
- **Function Generator**
  Ramps, Triangles, Exponentials & more to 2 MHz!
- **Pulse Generator**
  Digital waveforms with adjustable duty cycle

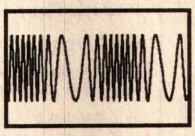
Telulex Inc. model SG-100



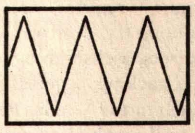
DC to 20 MHz linear and log sweeps



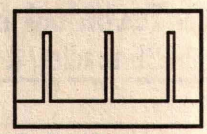
Int/Ext AM, SSB, Dualtone Gen.



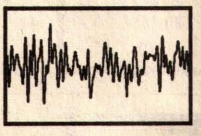
Int/Ext FM, PM, BPSK, Burst



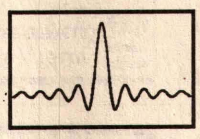
Ramps, Triangles, Exponentials



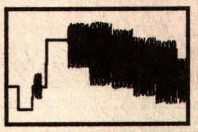
Pulse Generator



Noise



Arbitrary Waveforms



Unlimited Possibilities!

Telulex Inc.

2455 Old Middlefield Way S
Mountain View, CA 94043

Tel (650) 938-0240
Fax (650) 938-0241

http://www.Telulex.com
Email: sales@Telulex.com

CIRCLE 311 ON FREE INFORMATION CARD

PCBoards

PCB Artwork Made Easy!

PRINTED CIRCUIT DESIGN SOFTWARE

For Windows and DOS

Layout - Autorouting - Schematic - Circuit Simulation

- **NEW** 32 bit version available
- Ripup and Retry Router in Advanced Pkg.
- Copper Flooding for Building Ground Areas
- Gerber and Excellon Output
- Create Negative & Positive Printouts
- Create Single or Multi Layer Boards
- Create artwork from the Schematic
- **Analog and Digital Simulation** available
- Make boards up to 32" x 32"
- Parts Libraries - Silk Layers - Solder Mask
- **Great for All Circuit Design Projects!**
- **For the Professional and Hobbyist!**

Download DEMO - www.pcboards.net

Windows LAYOUT pgm. starts at **$149**

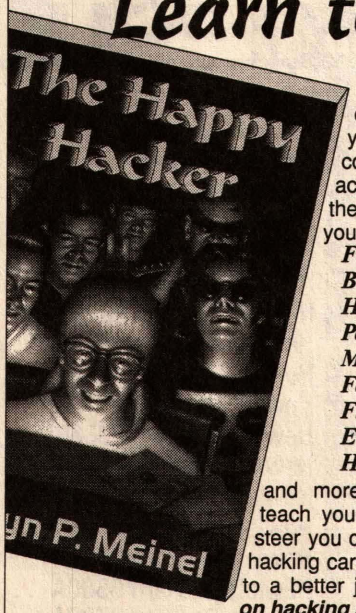
Windows Pkg. layout-schematic-router **$399**

Call or Write for Full Product Line, Prices & Free Demo

PCBoards
2110 14th Ave. South
Birmingham, AL 35205

(800)473-7227
Fax (205)933-2954
Phone (205)933-1122

Learn to Hack!



Finally, here is a no-nonsense technical book on computer hacking! In it you will learn how to hack computers you have physical access to and how to hack on the Internet. With this book, you will learn about:

Finding computers to hack
Breaking into computers
Hacking with Finger
Port surfing
Mapping the internet
Forging E-mail
Fighting spam
E-mail bombs
Hacker wars

and more! But this book will also teach you how to hack safely. It will steer you clear of the law, so that your hacking career won't lead to prison, but to a better job! ***By far, the best book on hacking available today!***

268 PAGE PAPERBACK, $29.95 SHIPPING $3

Call (800)719-4957 now!

to order (Visa/MC/COD) or call or write for **FREE CATALOG** of hard-to-get information about *computer viruses, computer hacking, security and cryptography*!!

Check our web site: ***www.logoplex.com/resources/ameagle***

American Eagle Publications, Inc.
P. O Box 1507, Dept E.
Show Low, AZ 85902

CIRCLE 282 ON FREE INFORMATION CARD

SURVEILLANCE

The Latest High Tech Professional Electronic Devices

Our latest catalog offers a HUGE selection of surveillance, counter-surveillance/privacy devices: **pinhole camera $129.00**, hidden video, ***"realtime"* 12-Hour telephone recorder $139.00**, 12 hour VOX recorder phone call register, scanners, bug/phone tap detectors, voice disguisers, locksmithing tools, vehicle tracking, wireless video, and much more. Wholesale/retail.

We will not be undersold.

Catalog $5.00 *or*

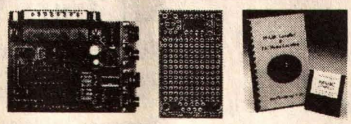
www.spyoutlet.com

SPY OUTLET

PO Box 337, Buffalo NY 14226

(716) 691-3476/(716) 695-8660

Low Cost PICmicro Tools



EPIC Pocket PIC Programmer - $59.95

- Programs PIC12C50x, 67x, 16C55x, 6x, 7x, 8x

PICProto Boards - $8.95 to $17.95

PicBasic Compiler - $99.95

***new*! PicBasic Pro Compiler** - $249.95

BASIC makes it easy for you to program the fast and powerful Microchip PIC microcontrollers.

- Expanded BS1/2 compatible instruction set
- True compiler provides faster program execution and longer programs than BASIC interpreters

microEngineering Labs, Inc.

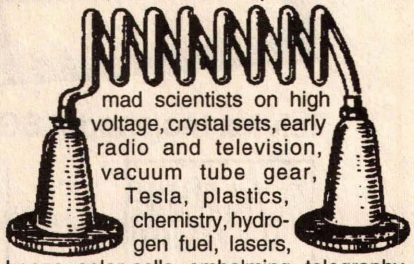
Box 7532 Colorado Springs CO 80933

(719) 520-5323 fax (719) 520-1867

http://www.melabs.com

SECRETS!

Unusual, detailed how-to books, manuals, references, old & new, for experimenters and



mad scientists on high voltage, crystal sets, early radio and television, vacuum tube gear, Tesla, plastics, chemistry, hydrogen fuel, lasers, booze, solar cells, embalming, telegraphy, more! Highest quality how-to! Guaranteed! Big illustrated catalog! fax:815/935-5477 Write! • http://www.lindsaybks.com

Lindsay's Technical Books

PO Box 538-EBF, Bradley, IL 60915

CONTROL YOUR WORLD

32K ModCon HC11

Low Cost Microcontroller boards & kits + Applications

ZORIN http://zorinco.com or call (206) 282-6061

Cable Television

Converters. equipment & test chips

Dealers wanted!!!

Best Prices and Service

30 Days Money Back 1 Year warranty!

1(800) 660-4180

HI-TECH SURVEILLANCE

Pinhole Cameras, Recording Devices, Bug Detectors, Lasers, Lockpicks, Pen Knives, Tracking Devices, Wireless Mics, Books/Videos, plus much more!!!!!

FOR CATALOG - SEND $5.00 TO:

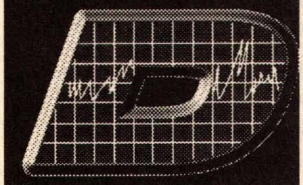
Spy Way

P.O. Box 61805, Jax, Fl 32236

Quality Reconditioned TEST EQUIPMENT

WANTED USED TEST EQUIPMENT

Visit us at our website www.danbar.com



DANBAR SALES COMPANY

EIP 545A	$1,500.00	Hewlett-Packard 5335A	$695.00
EIP 548	$2,500.00	HP 5342A/001,011	$1,350.00
EIP 548A Opt W36	$3,900.00	Hewlett-Packard 8349A	$2,250.00
Fluke 87 New	$275.00	HP 8350B/83592A	$12,000.00
HP 141T/8552B/8553B	$1,500.00	Hewlett-Packard 83594A/002	$14,700.00
HP 141T/8552B/8554B	$2,000.00	Hewlett-Packard 8562A	$25,000.00
HP 141T/8552B/8555A	$2,550.00	Hewlett-Packard 8566B	$39,500.00
Hewlett-Packard 1630D	$995.00	Hewlett-Packard 8568A	$13,000.00
Hewlett-Packard 1630G	$995.00	Hewlett-Packard 8569B	$7,900.00
Hewlett-Packard 1650A	$1,995.00	Hewlett-Packard 8590B	$8,000.00
Hewlett-Packard 3312A	$575.00	Hewlett-Packard 8640B	$1,250.00
Hewlett-Packard 3336B	$850.00	Hewlett-Packard 8657A/002	$3,900.00
Hewlett-Packard 355D New	$150.00	Hewlett-Packard 8662A	$28,700.00
Hewlett-Packard 3561A	$8,250.00	Hewlett-Packard 8671A	$4,250.00
Hewlett-Packard 3561A/001	$8,750.00	Hewlett-Packard 8901B	$,4,250.00
Hewlett-Packard 3562A	$10,700.00	Hewlett-Packard 8903B	$3,250.00
Hewlett-Packard 3580A	$900.00	Tektronix 465	$590.00
Hewlett-Packard 3582A	$1,995.00	Tektronix 468/02	$1,150.00
Hewlett-Packard 3586B	$1,000.00	Tektronix 494P	$12,500.00
Hewlett-Packard 435B /003 NEW	$750.00	Tektronix THS 710	$1,295.00
Hewlett-Packard 436B /022 NEW	$1,500.00	Wavetek 3520	$3,250.00
Hewlett-Packard 5334A	$695.00	Wiltron 6647B	$7500.00

(602) 483-6202 • (602) 483-6403 Fax

14455 North 79th Street, Unit #C • Scottsdale, Arizona 85260

CIRCLE 235 ON FREE INFORMATION CARD

Roger's Systems Specialist

Best Prices!

Best Service!

Call today for a FREE catalog.

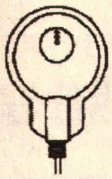
20' Audio Cable

Stereo extension cables, for speakers and headphones 3.5mm, gold plated male to female, shielded, 20 ft.

#AC-560.....$4.50 each

Microphone

Stick-on monitor or clip on shirt, 6 ft. cord, condenser mic.



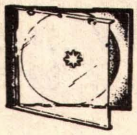
#TM-MIC-2
$1.00 each

Mouse Pad

Sponge rubber backing to prevent sliding, many colors available, call for details.

#TM-PAD.....$1.00 each

CD Jewel Case



Replacement for original case. durable plastic.

#TM-CD-1....3/$1.00 each

Network Cards

Plug and Play
auto sensing BNC and UTP ports
on-board 32k sram buffer to speed data transmission
NE2000 compatible

16-bit ISA 10Mbps
#NT-TBT-10.....$17.00 each
32-bit PCI 10Mbps
#NT-TBT-200.....$17.00 each
32-bit PCI 100 Mbps
#NT-TBT-100.....$34.00 each

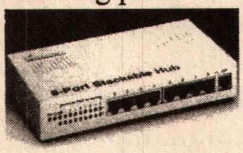
10Base-T Hub

5 port
IEEE 802.3
10Base-T compliant
RJ-45 cascading port
auto-partioning
10Mbps

#TM-TBT-HUB5.....$55.00 each

10Base-T Hub

8 port
IEEE 802.3
10Base-T compliant
BNC or RJ-45 cascading port
auto-partioning
10Mbps



#TM-TBT-HUB.....$69.00 each

100 Mbps Fast Ethernet Hub

5 port
IEEE802.3u Class II
Link/Activity/ Partition LED

#TM-TBT-5100.....$135.00 each

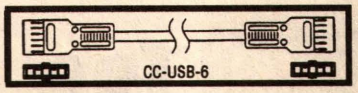
Check out these products and more on our newly redesigned web site.

www.rogerssystems.com

Mention this ad when you order on-line and receive a FREE gift!

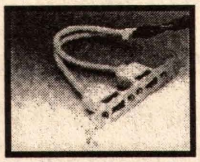
USB Cable

Male to male "A" to "A", shielded, 6 ft.



#CC-USB-6.....$5.00 each

USB Ports



USB(2) to 10 pin motherboard w/ bracket

#TM-USB-9.....$7.00 each

Universal Serial Bus Hub

USB hub, 4 port

#TM-USB-4HUB.....$79.00 each

7-port also available

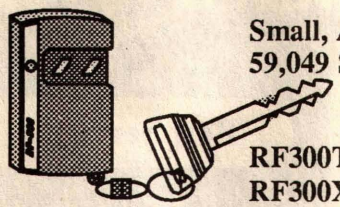
Local 805-295-5577 Remember, We Have Great Connections...For You! **FAX 805-295-8777**

$10.00 minimum order required • Add $4.50 shipping for pre-paid orders
California residents add 8.25% tax • eMail sales@rogerssystems.com
Call for quantity discounts • No out of state checks accepted • Most orders shipped same day!

24895 Avenue Rockefeller, Valencia, CA 91355

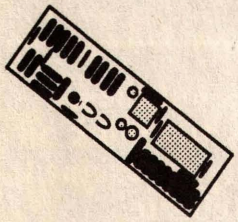
CIRCLE 216 ON FREE INFORMATION CARD

Miniature Transmitters and Receivers



Small, Attractive, High End Quality, 2 Channel 318 MHz Transmitter
59,049 Settable Codes, 120'–300' Range, 1–1/4" x 2" x 9/16", Assembled

	Qty	1	5	10
RF300T	150' Range Transmitter	24.95	19.95	15.95
RF300XT	300' Range Transmitter	29.95	24.95	19.95



Small, High End Quality, 2 Channel Receiver for the RF300 Transmitters
1–1/4" x 3–3/4" x 9/16" PCB w/ .1" spaced pads for standard connectors
Input: 8–24 vdc Output: Gated CMOS Momentary and Latching Lines

	Qty	1	5	10
RF300R	Receiver, Fully Assembled	24.95	20.95	16.95
RF300RK	Receiver, Complete Parts Kit	19.95	15.95	12.95
RF300PA	Pre–Amplifier. Doubles Range	14.95	11.95	9.95

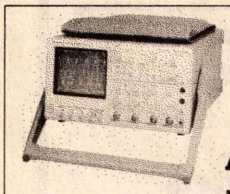
Small, Economical, Single Channel Transmitter and Receiver Set
Set Code, 60' Range, 1–7/8"x2–3/8"x7/16" (T), 2"x2–3/4"x9/16" (R)
Receiver Input: 5 vdc Output: Gated TTL Momentary Line

	Qty	1	5	10
RF60	Transmitter and Receiver Set	24.95	19.95	14.95

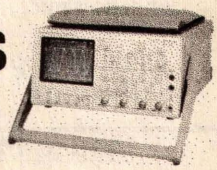
Add $ 4 shipping for first item + $ 1 for each additional item. Ca. residents add 8.25% tax
Visa, Mastercard, Money Orders Personal Checks and Cash C.O.D.s

Visitect Inc. P.O. Box 14156 Fremont, CA. 94539 (510) 651–1425 Fax (510) 651–8454

CIRCLE 310 ON FREE INFORMATION CARD



Test Equipment Sales



Ask about our line of new products including
HP, LeCroy, Instek,Tektronix, Fluke and more !

Here is a sample of our used equipment inventory

HP 8165A 50MHz PROG.SIG.SOURCE..$1195
HP 3325A-002 GENERATOR W/OPT.....$1595
WAV 801 50 MHz PULSE GENERATOR.....$650
BAL 6127B SCOPE CALIBRATOR.....$1995
TEK SG503 LEVELED SINE GENERATOR...$595
TEK 2235 100 MHz 2 CH. SCOPE.....$895
SOR DCS55-55 PROG. DC P.S.....$1195
DIO 1020L PROGRAMMER M/F.....$595
MINOLTA CA100 COLOR ANALYZER.$1795
HP6205B DC POWER SUPPLY.....$195
TEK 2465A 350MHz 4 ch. SCOPE....$3495
TEK 2465B 400MHz 4 CH. SCOPE....$6395
BMI 2400 POWER ANALYZER.....$895
RODL M30 30A GROUND TESTER....$1395
TEK PS503A TRIPLE OUTPUT SUPPLY....$195
TEK DC504A COUNTER P/I.....$225

WE BUY SURPLUS

CHECK OUT OUR NEW ARRIVALS AND MONTHLY SPECIALS AT WWW.TESALES.COM

WWW.TESALES.COM

CALL 800 684-4651 OR FAX (603) 425-2945

LOCATED IN TAX FREE NEW HAMPSHIRE

CIRCLE 217 ON FREE INFORMATION CARD

RAMSEY

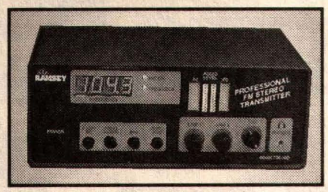
World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture!

Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Audio units include sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Any of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air!

C-2000, Basic Video Transmitter Cube.....$89.95
C-3000, Basic Video and Audio Transmitter Cube.....$149.95
C-2001, High Power Video Transmitter Cube.....$179.95
C-3001, High Power Video and Audio Transmitter Cube.....$229.95

Super Pro FM Stereo Radio Transmitter



A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes cabinet, whip antenna and 120 VAC supply.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit.....$299.95
FM-100WT, Fully Wired High Power FM Transmitter.....$429.95

AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, 'pro' version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper setable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded wire antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25, Professional AM Transmitter Kit.....$129.95
AM-1, Entry level AM Radio Transmitter Kit.....$29.95
CAM, Matching Case Set for AM-1.....$14.95

CCD Video Cameras

B&W Camera

Color Camera

If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays with over 440 line line resolution, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. Also, a new strain of CMOS single chip cameras are entering the market, those units have about 1/2 the resolution and draw over twice the current that these cameras do - don't be fooled! Our cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, the black & white models are super IR (Infra-Red) sensitive. Our IR-1 Illuminator kit is invisible to the human eye, but lights the scene like a flashlight at night! Color camera has Auto White Balance, Auto Gain, Back Light Compensation and DSP! Available with Wide-angle (80º) or super slim Pin-hole style lens. They run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our IB-1 Interface board for audio sound pick-up and super easy direct wire hook-up connection to any Video monitor, VCR or TV with video/audio input jacks. Cameras fully assembled, including pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens.....$99.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole len.....$99.95
CCDPH-2, Color CCD Camera, wide-angle lens.....$149.95
IR-1, IR Illuminator Kit for B&W cameras.....$24.95
IB-1, Interface Board Kit.....$24.95

FM Stereo Radio Transmitters

Microprocessor controlled for easy frequency programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit.....$129.95

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice finished look.

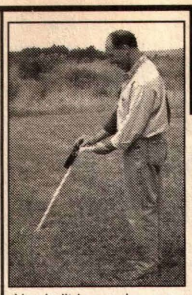
FM-10A, Tunable FM Stereo Transmitter Kit.....$34.95
CFM, Matching Case and Antenna Set.....$14.95
AC12-5, 12 Volt DC Wall Plug Adapter.....$9.95

RF Power Booster

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat, professionally finished look, add the optional matching case set.

LPA-1, Power Booster Amplifier Kit.....$39.95
CLPA, Matching Case Set for LPA-1 Kit.....$14.95
LPA-1WT, Fully Wired LPA-1 with Case.....$99.95

Treasure Finder Kit



Search for buried treasure at the beach, backyard or park. This professional quality kit can detect metal at a depth of up to 6 inches. Easy to use, just listen for the change in tone as you 'sweep' the unit across the surface - the larger the tone change - the larger the object. Has built-in speaker or earphone connection, runs on standard 9 volt battery. Complete kit includes handsome case, rugged PVC handle assembly that 'breaks down' for easy transportation and shielded Faraday search coil. Easy one evening assembly. This nifty kit will literally pay for itself! That guy in the picture looks like he found something - what do you think it is - gold, silver, Rogaine, Viagra? You'll have fun with this kit.

TF-1, Treasure Finder Kit.....$39.95

Binocular Special

We came across these nice binoculars in an importers close-out deal. Not some cheap in-line lens jobs, these beauties have roof prisms, a super nice rubber armored housing over light weight aluminum. 10 x 25 power with fully coated optics. Includes lens cleaner cloth, neck lanyard and nice carry case. For extra demanding use in bright sun, choose the EX module with ruby coated Objective lens. First quality at a close-out price! We've seen the exact same units with the 'Bushnell' name on them being sold for $30 more!

BNO-1, Binoculars and case.....$24.95
BNO-1EX, Ruby Coated Lens Binoculars and case.....$29.95

Speech Descrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. Speech inversion technology is used, which is compatible with most cordless phones and many police department systems, hook it up to your scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC. Our matching case set adds a professional look to your kit.

SS-70A, Speech Descrambler/Scrambler Kit.....$39.95
CSS, Custom Matching Case and Knob Set.....$14.95
SS-70AWT, Fully Wired SS-70A with Case.....$79.95
AC12-5, 12 Volt DC Wall Plug Adapter.....$9.95

Call for our Free Catalog !

See our complete catalog and order on-line with our secure server at:
www.ramseyelectronics.com

RAMSEY ELECTRONICS, INC.
793 Canning Parkway Victor, NY 14564

Order Toll-free: 800-446-2295
Sorry, no tech info, order status at this number

Technical Info, Order Status
Call Factory direct: 716-924-4560
Fax: 716-924-4555

VISA MasterCard DISCOVER

ORDERING INFO: Satisfaction Guaranteed. Examine for 10 days, if not pleased, return in original form for refund. Add $6.95 for shipping, handling and insurance. Orders under $20, add $3.00. NY residents add 7% sales tax. Sorry, no CODs. Foreign orders, add 20% for surface mail or use credit card and specify shipping method.

CIRCLE 266 ON FREE INFORMATION CARD

CABLE TV EQUIPMENT

Converters, Test Cubes & Chips

1 Year Warranty
30 Day Money Back Guarantee

"ABSOLUTE LOWEST WHOLESALE & RETAIL PRICES"

CABLE U.S.A.
1-888-388-CUBE

Zagros Robotics
World Class Engineering and Programming

ROBOTS
SONAR
OPTICS
Artificial Intelligence

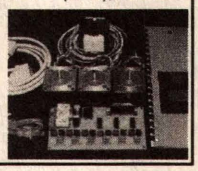
PO Box 460342
St. Louis, MO 63146-7342
(314)768-1328
info@zagrosrobotics.com
www.zagrosrobotics.com

---

3 Axis Motion Control System
Complete, ready to run
$ 255.50 + 12.00 S/H

Build or adapt CNC mills, CNC routers, Robots, Etc. Includes: 3 Stepping motors (70 oz/in 200 steps/rev). External board (connects to parallel port of a PC). Power supply. Cables, Manual and the MAXNC drive software, with linear, circular and helical interpolation, acceleration deceleration, full contouring, 'G' code programming, screen plot, code generation from CAD (CAM), and more.

For more information, phone or write to:
MAXNC
6730 West Chicago
Suites 2 & 3
Chandler, AZ 85226
Ph (602) 940-9414
Fax (602) 940-2384



Turn Your Multimedia PC into a Powerful Real-Time Audio Spectrum Analyzer

Features

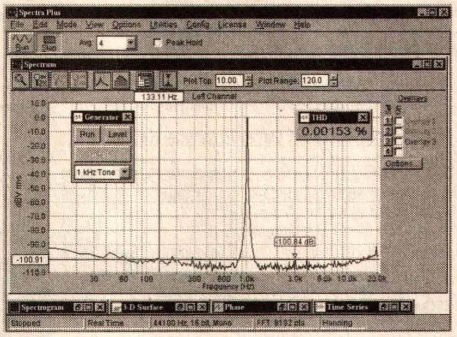
- 20 kHz real-time bandwith
- Fast 32 bit executable
- Dual channel analysis
- High Resolution FFT
- Octave Analysis
- Distortion measurements
- Signal Generation
- Triggering, Decimation
- Transfer Functions, Coherence
- Time Series, Spectrum Phase, and 3-D Surface plots
- Real-Time Recording and Post-Processing modes

Applications

- Distortion Analysis
- Frequency Response Testing
- Acoustic Research

System Requirements

- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win.32s
- Mouse and Math coprocessor



Priced from $495

(U.S. sales only – not for export/resale)

DOWNLOAD FREE 30 DAY TRIAL!

www.spectraplus.com

PHS Pioneer Hill Software
24460 Mason Rd.
Poulsbo, WA 98370
a subsidiary of Sound Technology, Inc.

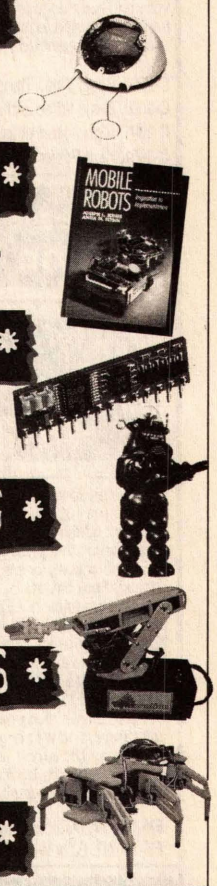
Spectra Plus
FFT Spectral Analysis System

Sales: (360) 697-3472 *Fax: (360) 697-7717* *e-mail: pioneer@telebyte.com*

MONDO·TRONICS'

ROBOT STORE

* KITS *
Your
* BOOKS *
Mailorder
* PARTS *
Source
* VIDEOS *
For
* MODELS *
Robots!
* MORE! *



(REQUEST OUR FREE CATALOG)

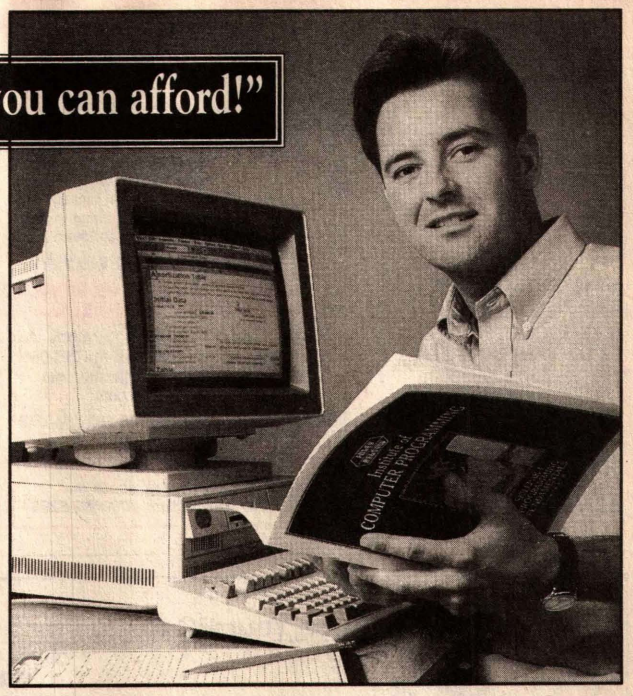
www.robotstore.com

800-374-5764

Or write to us:
4286 Redwood Hwy #226-137
San Rafael CA 94903
Phone 415-491-4600 • Fax 415-491-4696
Email info@mondo.com

"Get the skills you need at a price you can afford!"

Earn up to $45 an hour or more as a skilled Computer Programmer.



Cash in on the explosion of opportunities. Start your new career or even open a business of your own as a highly-paid computer programmer.

Computer programmers today can almost write their own ticket to financial well-being and job satisfaction. Only Foley-Belsaw's unique in-home training programs can give you the skills you need at a price you can afford.

You'll learn the three hot computer languages — QBasic, C and Visual Basic. You'll even work with the hot new C++. With this easy-to-learn knowledge, you'll write your first QBasic program by the end of the first SkillPak of lessons. Soon you'll be programming sound and graphics, and even learning how to program for the Windows environment — the most popular application program today.

It's easy to cash in!

Look at some of the things professional computer programmers do. "Wrote a C program to clean up a WordPerfect file; edited the resulting file as data errors were found." This work would take a trained programmer less than five hours to complete, and they could make over $200 for the work. That's money you could be making — and soon — with training from the Foley-Belsaw Institute of Computer Programming.

Everything is included!

We provide you with all the materials you'll need to become a professional computer programmer. You'll receive 37 lessons, designed for you by the Foley-Belsaw Professional Programmer Staff. Other valuable materials include a *Programmer's Handbook*, Programmer's Examples on two 3.5 inch disks, Programmer's Flowchart Template, and a booklet, *Selecting the Right Computer*.

Other schools force you to buy a complete computer package as part of their training program. At Foley-Belsaw we understand that your needs as a programmer may not fit into a "one size fits all" approach. Why should you pay hundreds of dollars for a computer system that you may not need?

We'll tell you what you need to know so that when you're ready to buy your own computer, you can get the machine that fits your needs at the lowest possible price. That's the Foley-Belsaw way.

Get the free facts today.

Whether you want to change careers, have a profitable part-time job or start your own business, Foley-Belsaw Institute's new computer programming course is the first step. A profitable future in computer programming can be yours. Call or write today for a fact-filled information kit including a free copy of *Computer Programming — A Profitable Career In Your Spare Time*. See how easy it is to begin a money-making career as a sought-after computer programmer. Our free full-color information kit outlines the steps of the computer programming course and shows you everything you will receive as part of your training.

Mail this coupon or call today
Toll Free 1-800-487-2100!
Your free opportunity kit will be rushed to you!

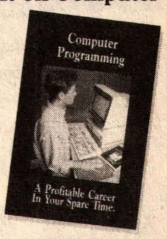
If coupon is missing, write to: Foley-Belsaw Company, 6301 Equitable Road, Kansas City, MO 64120

Call or complete & return this coupon to: Foley-Belsaw Institute,6301 Equitable Road, Kansas City, MO 64120

❑ **YES! Rush me a free information kit on Computer Programming right away. Dept. 35571**

Other career courses:

- ❑ Locksmithing, Dept. 13153
- ❑ Small Engine Repair, Dept. 53027
- ❑ Saw & Tool Sharpening, Dept. 21959
- ❑ VCR Repair, Dept. 62853
- ❑ Computer Repair, Dept. 64755
- ❑ TV/Satellite Dish Repair, Dept. 31624
- ❑ Gunsmithing, Dept. 92660
- ❑ Woodworking, Dept. 43891
- ❑ Upholstery, Dept. 81563
- ❑ Vinyl Repair, Dept. 71494
- ❑ Electrician, 95432
- ❑ Computer Specialist, Dept. 38393
- ❑ Networking Specialist, Dept. 39380



FOLEY BELSAW Since 1926

I understand that there is ABSOLUTELY NO OBLIGATION and NO SALESMAN WILL CALL.

Name _____

Address _____

City _____ State _____ Zip _____

CIRCLE 335 ON FREE INFORMATION CARD

The World's Largest Source for Home Automation

- The Best & Most Comprehensive Home Automation Catalog in the Industry
- Best Customer Service & Technical Support

FREE 144 page full color catalog!

Thousands of hard-to-find automation, X-10 and wireless control products. Computer interfaces, software, development tools, lighting control, telephone systems, security systems, surveillance cameras, infrared audio/video control, home theater, touchscreen control, HVAC, pet care automation, wiring supplies, books and videos and much more!

World's Largest Selection!

Lowest Prices Guaranteed!

HOME AUTOMATION SYSTEMS, INC.
Questions: 714-708-0610 *Fax:* 714-708-0614
e-mail: catalog@smarthome.com
www.smarthome.com

Call for a *FREE* Catalog! 800-762-7846

800-SMART-HOME

Dealers/Resellers ask about our HASPRO Dealer Program 800-949-6255

EPROM+

The Professionals Choice!

A rugged device programming system for bench and field

Uses parallel printer port!
Supports all standard parts!
Excellent, easy-to-use software!

FIRST GENERATION EPROMS 2708, TMS2716*, 25XX
SECOND GENERATION EPROMS (24, 28, 32 PIN) 2716 - 27C080 (8 MEG)
16 BIT EPROMS* (40, 42 PIN) 27C1024 - 27C160 (16 MEG)
FLASH EPROMS (28, 32 PIN) 28F, 29C, 29EE, 29F FAMILIES PLUS BOOT BLOCK DEVICES
EEPROMS/NVRAMS (24, 28, 32 PIN) 28C04 - 28C010, X2210/12, ER5901, PLUS DALLAS 12XX
SERIAL EEPROMS* (8, 14 PIN) 17XX, 24XX, 25XX, 35XXX, 59XX, 85XX, 93XX, 95XX+ER1400
BIPOLAR PROMS* (16 - 24 PIN) 74SXXX AND 82SXXX FAMILIES
MICROCONTROLLERS* (ALL FAMILIES) 874X, 875X, 87C5XX, 87C75X, 89C5X, 89CX051 89SXXXX, 90SXXXX, 68705, 68711, PIC12CXXX - 16CXXX, 17C4X PLUS FLASH AND 14000

*ADAPTER REQUIRED DIAGRAMS INCLUDED

- READ, PROGRAM, COPY, COMPARE, FILE LOAD/SAVE (PLUS MUCH MORE!)
- FULL SCREEN EDITOR W/25 CMDS + BYTE/WORD MODES
- RUNS UNDER DOS, WIN3.1/95/98 AT ALL CPU SPEEDS
- SUPPORTS INTEL HEX, S-RECORD AND BINARY FILES
- MADE IN USA • 30 DAY MONEY BACK GUARANTEE

$289

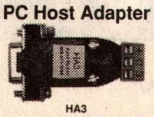
SYSTEM INCLUDES: PROGRAMMING UNIT, PRINTER PORT CABLE, POWER PACK, SOFTWARE & MANUAL

$5.00 SHIPPING • $5.00 C.O.D.
VISA•MASTERCARD•AMEX

ANDROMEDA RESEARCH, P.O. BOX 222, MILFORD, OH 45150
(513) 831-9708 FAX (513) 831-7562 website - www.arlabs.com

Use Your PC to Monitor and Control Your Environment

PC Host Adapter



HA3

RS232 to 1-Wire™ protocol host adapter interface. Converts standard PC serial port to a 1-Wire™ network. All interface components are contained inside the DB9 shroud. The HA3 supports all Point Six Products.
- No external power required.
- Includes OneSix™ DDE Server Software.
- Connects to 9 pin RS232 port on the PC.
- 2000 ' Network and 200 1-Wire™ devices.
- Weight 0.5 lb.
- One-year warranty.

OneSix™ DDE Server

A software server driver for Windows® 95, 3.1 and 3.11 that allows easy interface of 1-Wire™ devices and Point Six products to applications via DDE links. This eliminates the need for low level device communication programming.
- Searches network, adds and auto configures all new devices found.
- Copy and paste links to Office® products like Excel®, Word® and many other DDE capable applications.
- Works with HMI interface software such as Wonderware®, LabView®, and TestPoint®.
- Includes complete help. • Includes an HA3 Host Adapter.
- Weight 0.5 lb. • One-year warranty.

1-Wire™ Probes

STP010

Our probe designs are based on 1-Wire™ protocol devices. All probes are multi-dropable and supported by OneSix™ DDE Server Software.
- Digital Data Output.
- Built-in multi-drop controllers. • All Data is CRC16 error checked.
- Unique device addressing.
- Calibration data stored in internal ROM memory.
- No external power required.
- Standard Temperature Range -30 to +182°F.
- Requires Host Adapter or existing network.
- Weight 1.0 lb. • One-year warranty.

Very Low Cost Per Point Temperature Monitoring

Item	Description	Price
HA3	Host Adapter	69.95
ONESIX	DDE Server Software Driver	69.95
T1SS	Single Channel Digital I/O Solid State Relay Backplane	29.95
STP010	Standard Temperature /W 10' Lead	14.95
STP025	Standard Temperature /W 25' Lead	16.95
PRP001	Pressure Probe 0-30 PSI Absolute	159.95
PHP001	pH Probe 0-14pH	159.95
HMP001	Humidity Probe 0 - 100% RH	159.95
FCP001	Force Probe 1500gm	179.95
DS1820	Digital Thermometer Chip	3.49

Two wire multi-drop network based on Dallas Semiconductor 1-Wire™ Protocol

MasterCard VISA

http://www.pointsix.com

Example: 25 Digital Thermometer Chips, 1000ft Cat-5 Cable, HA3 Host Adapter, OneSix™ DDE Server Software Driver, and Windows® Monitoring Application all for less than $10 per point.

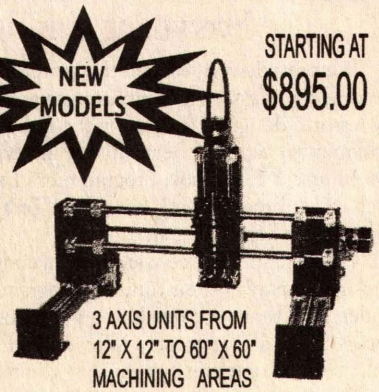
Point Six, Inc. To Place An Order Contact Us At 138 E. Reynolds Road Lexington, KY 40517 Phone: 606-271-1744 FAX: 606-271-4695 E-Mail: sales@pointsix.com

CAD FILES TO CASH PILES

IMAGINE THE POSSIBILITIES!
ROUTE, MILL, DRILL, CARVE,
ENGRAVE, PAINT, ETC. . . . .
IN WOOD, PLASTIC, VINYL,
PC BOARD, & LIGHT METALS.

NEW MODELS

STARTING AT $895.00



THE **ROBOPRO X50**
CNC ROBOTIC MACHINING SYSTEM

YOUR WISH IS ITS COMMAND!

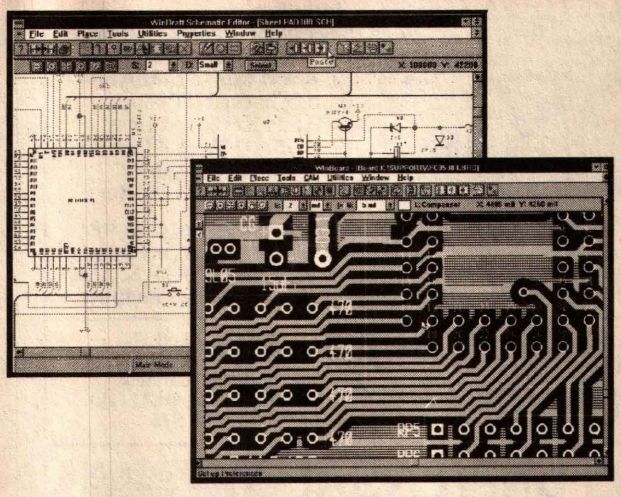
3 AXIS UNITS FROM 12" X 12" TO 60" X 60" MACHINING AREAS

Visit us at www.uscyberlab.com

U. S. CYBERLAB, INC., 14786 SLATE GAP RD., WEST FORK, AR 72774
VOICE (501) 839-8293 / 24 HR. FAX BACK (501) 839-8293

Electronic CAD for Windows

Professional Windows EDA tools at an affordable price with powerful features to make designing faster. WinBoard PCB layout delivers sophisticated interactive routing for complex designs, plus it has the tools needed for high-speed circuits, analog, RF and SMT designs.



WinDraft® Schematics

- Use True-Type fonts. Quickly copy and paste into other applications.
- Supports hierarchical designs, electrical rules checking, Annotation & Bill of Materials.
- Thousands of library parts and symbol editor included.

WinBoard™ PCB layout

- Supports 16 layers, multiple copper pours, and advanced features for RF designs.
- SMD & through hole library with on-line graphical editor.
- CAM outputs include BOM, in-circuit test, NC Drill, Gerber, Pick & Place, & Advanced Design Rule Checking (DRC).

With our unique ***pin capacity*** versions you only pay for what you need. You choose the base configuration to suit your needs today, and expand that configuration to handle increased pin capacity as your design requirements change.

WinDraft 2.0 Available Now

$ 250 **WinDraft or WinBoard - P650**
$ 495 **WinDraft or WinBoard - unlimited**

$ 895 **WinBoard P650 with CCT Specctra® autorouter.**

Thousands of satisfied customers are using this new generation of powerful and affordable Windows EDA tools from Ivex. Your satisfaction is guaranteed!

World Wide Web: http://www.ivex.com

Information and free evaluation version is available on the Ivex WW Web, FTP and BBS.

Tel: (503) 531-3555
Fax: (503) 629-4907
BBS: (503) 645-0576

IVEX™ DESIGN INTERNATIONAL

Ivex Design International. 15232 NW Greenbrier Parkway. Beaverton, Oregon 97006. USA.

ADV2_1

CIRCLE 319 ON FREE INFORMATION CARD

Look What As Little As $25 A Month Can Get You These Days.

Help with college degrees. Fast cars. A first home. With as little as $25 a month, a gift of U. S. Savings Bonds can help your kids with all kinds of future needs.

For more information, call toll free:
1-800-4US BOND.

Take Stock in America U.S. SAVINGS BONDS

www.savingsbonds.gov

ELECTRONIC SHOPPER

Filter Wiz v2.0

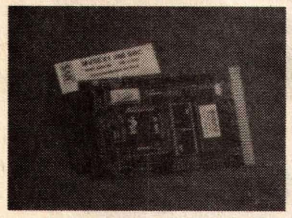
ACTIVE FILTER design software for Windows. Provides mastery of lowpass, highpass, bandpass and bandstop filters. Enhance critical signal components while controlling noise and other interference. Meets the needs of both novice and professional designer. Standard (LE) version $89, PRO version $199.

Download: http://www.schematica.com

sales@schematica.com FAX:250-642-2644

386 MINI-PC $83

1K PRICE
EVAL $295
8088 $27



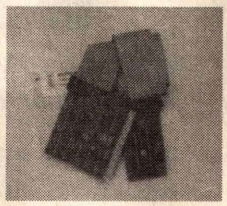
includes:
- -5 Serial,3 Parallel (32bit max)
- -Up to 8 meg ROM (27C080)
- -32k RAM exp. to 64Mbyte
- -Battery backed RT Clock
- -LCD and Keyboard ports
- -IRQ x15, DMA x2, TIMER x4
- -On-board LED display
- -Industry Standard PC Bus

Perfect when a full-size PC is too large, expensive, or power hungry. A fully functional single board computer, needs only program and power source. Runs DOS / WINDOWS. Use Turbo C, BASIC, MASM. All utilities to do this included.

A to D D to A CONVERTERS

For PC or SBC
8,12,16 bit resolution
up to 24 channels
starting at $21 OEM (1k)
eval kit $75

$95 UNIVERSAL PROGRAMMER



FLASH, EEPROM, NVRAM, EPROM up to 8 meg (27C64-080). Adapters for micros, PLCC, etc. Parallel port version for notebook. FAST AND EASY TO USE.

LOW COST... LOW POWER...

LOW RISC!

QTY 1K PRICE
$1.99
EVAL KIT 7.00

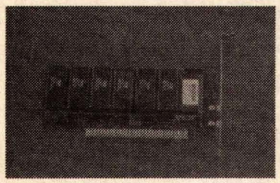
LOWER COST, FASTER, EASIER TO PROGRAM SINGLE CHIP COMPUTER

COMPARE:	16C54	MV1200
OEM (1K) PRICE	$2.57	$1.99
RS232 PROGRAM DOWNLOAD	NO	YES
SINGLE CHIP OPERATION	NO	YES
BUILT-IN BASIC	NO	YES
EEPROM DATA MEMORY	NONE	64
PROGRAM MEMORY	768 OTP	1K FLASH
MATH REGISTERS	1	32
MAX INSTRUCTIONS / SEC	5M	20M
MAX COUNTER BITS	16	18
INPUT / OUTPUT BITS	12	15
A TO D COMPARATOR	NO	YES
HARDWARE INTERRUPTS	NONE	3

PINOUT:

RESET	1	20	VCC
PD0	2	19	PB7
PD1	3	18	PB6
XOUT	4	17	PB5
XIN	5	16	PB4
PD2/INT	6	15	PB3
PD3	7	14	PB2
PD4/TMR	8	13	PB1/AD1
PD5	9	12	PB0/AD0
GND	10	11	PD6

- LONG WORD INSTRUCTION - FRIENDLY SYMMETRIC ARCHITECTURE -



PC SOLID STATE DISK

$21 OEM (1k) eval kit 75.00
FLASH / RAM / EPROM
256K-16M PCMCIA/DIPS

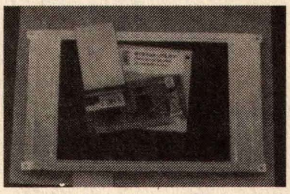
No More Hangups...

PC WATCHDOG!

Reboots PC OEM $21 EVAL $75

VGA LCD

640x480 controller for PC or SBC
$27 oem $95 eval
combo LCD/CRT
version available



visit our web site: www.star.net/people/~mvs

MVS BOX 850
MERRIMACK,NH 03054
(508) 792-9507

MVS

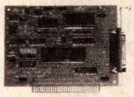
5yr Limited Warranty
Free Shipping
Hrs: Mon-Fri 10-6 EST

CIRCLE 324 ON FREE INFORMATION CARD

DATA ACQUISITION & CONTROL

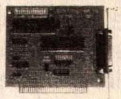
AFFORDABLE PLUG-IN BOARDS FOR PC's ISA BUS

ANA100 Analog I/O ..... $ 99



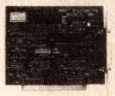
- * 8 Channel 8-Bit
- * 0 to 5 Volt Input
- * 14 TTL I/O lines
- * Analog Output
- * 400KHz Sampling

DIG100 Digital I/O ..... $ 39



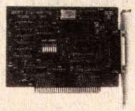
- * 82C55 PPI
- * 24 or 48 TTL I/O Lines option
- * Selectable Base Address

ANA150 Analog/Counter... $ 89



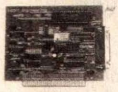
- * 8 Channel 8-Bit 0 to 5 Volt input
- * 3 16-Bit Counters
- * 400KHz Sampling

DIG200 Counter I/O ..... $ 79



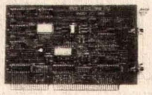
- * 3 16-Bit Counters
- * 8 TTL Input lines
- * 8 TTL Output lines
- * Selectable Clock Frequency input

ANA200 Analog I/O ..... $ 79



- * 1 Channel 12-Bit 0 to 5 Volt input optional bi-polar
- * 100KHz / 300KHz Sampling rate
- * 24 TTL I/O lines

ANA201 Analog ..... $ 119



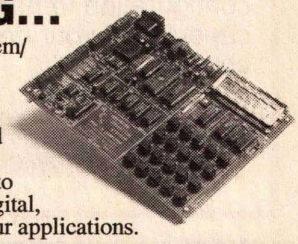
- * 8 Channel 12-Bit
- * x1, x5, x10, x50 Programmable Channel gain
- * 100KHz Sampling rate

On-Line Product Catalog at Our Web Site
http://www.Bsof.com
E-Mail: Sales@Bsof.com

BSOFT Software, Inc.

444 COLTON ROAD * COLUMBUS, OH 43207
PHONE 614-491-0832 * FAX 614-497-9971

Learn MICROCONTROLLERS EMBEDDED SYSTEMS and PROGRAMMING...



...with the AES learning system/ embedded control system. Extensive manuals guide you through your development project. All programming and hardware details explained. Complete schematics. Learn to program the LCD, keypad digital, analog, and serial I/O. for your applications.

THREE MODELS AVAILABLE. Choose from an Intel 8051, Intel 8088, or Motorola 68HC11 based system. All models come with:

• 32K Byte ROM, 32K Byte RAM • 2 by 16 Liquid Crystal Display • 4 by 5 Keypad • Digital, Analog, and Serial I/O • Interrupts,timers, chip-selects • 26 pin expansion connector • Built-in Logic Probe • Power Supply (can also be battery operated) • Powerful ROM MONITOR to help you program • Connects to your PC for programming or data logging (cable included) • Assembly, BASIC, and C programming (varies with model) • Program disks with Cross Assembler and many, well documented, program examples • User's Manuals: cover all details (over 500 pages) • Completely assembled and ready to use • Source code for all drivers and MONITOR • Optional Text Book

Everything you need. From $279.
Money Back Guarantee

Call for Free Info Pack, or see WEB at http://www.aesmicro.com
714-550-8094, FAX 714-550-9941

AES
Advanced Educational Systems

Call 1-800 -730-3232

AES 575 ANTON BLVD., SUITE 300, COSTA MESA, CA 92626, USA

ALL ELECTRONICS CORPORATION

QUALITY PARTS

FAST SHIPPING

DISCOUNT PRICING

CALL, WRITE, FAX or E-MAIL For A Free 96 Page CATALOG.
Outside the U.S.A. send $3.00 postage.

Special Low Price! AA NICKEL-CADMIUM RECHARGEBLE BATTERY

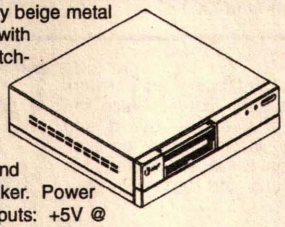
Motorola
0.56" dia.X 1.97" long

CAT# NCB-AA

$1.25 each

10 for $11.00
100 for $100.00

Incredible Deal !! METAL ENCLOSURE WITH POWER SUPPLY AND FAN



High-quality beige metal enclosure with built-in switching power supply, 60mm square fan (12 Vdc) and 2.25" speaker. Power supply outputs: +5V @ 6A, +12V @ 1A, -5V @ 0.1A, -12V @ 0.3A. On-off push switch, speaker and LEDs in front panel. Rear panel has IEC power receptacle and cutouts for other connectors. Exterior dimensions: 12" x 12" x 2.5". Front panel has a cutout for a 1/2 height drive. Vents in sides and rear. Plastic front panel with AT&T logo. Includes stick-on rubber feet and ribbon cable w/ 40 pin connectors.

CAT # MB-68 **$11.00 each**

Great Price! "EAR BUD" STEREO EARPHONES

Miniature "in-ear" earphones for use with most portable CD, radio and tape players. Gold-plated 3.5 mm stereo phone plug. 32 ohm impedance.

Large Quantity Available

CAT #HP-6

85¢ each

10 for $7.50
100 for $50.00

UV Blacklight

New black-light lamps designed by Avon Cosmetics to highlight dry skin. They have a built-in timer that shuts-off the lamp after approximately one minute. Ideal for lighting fluorescence in black-light posters, gemstones, hand stamps and US currency. 5" lamp, F4T5BLB, is housed in a lightweight plastic case. 7" x 3.25" x 2.3" high. Powered by a 12 Vdc, 500 ma wall transformer (included). Individually boxed.

CAT# UVL-1 **$10.00 each**

F4T5-BLB. Replacement lamp for fixture above. **CAT # BLB-5** $3.00 ea.

HEAVY DUTY LIGHTER CORD

Cigarette lighter plug with replaceable 3AG fuse. 2.1 mm, center positive co-ax power plug on other end. 5' black SPT-2 cable. Good quality assembly. Large quantity available.

CAT# CLP-39

$1.25 each

10 for $9.00
500 for $425.00 (85¢)
1000 for $700.00 (70¢)

Filtered Modular Jack

Corcom # RJ11B-4L-B
"Signal Sentry™"
4 pin, RJ-11 modular jack with built-in ferrite block for inductive filtering. Fits the same space as non-shielded jacks. 0.52" x 0.8" x 0.59" high. UL, CSA. Large quantity available.

CAT # MT-4F **$1.25 each**

10 for $10.00 • 100 for $85.00

RED Ultrabright LED

PAINFULLY BRIGHT RED LED
2500 to 4000 mcd @ 20 ma. These T 1 3/4 (5 mm diameter) red LEDs are significantly brighter than conventional LEDs. At close range, they are painful to look at. They are great for attention getting displays that can be seen from a distance. Water clear in off-state.

CAT # LED-42

2 for $1.20

10 for $5.00
100 for $45.00
1000 for $400.00

5 Vdc D.P.D.T. DIP RELAY

NAIS # DS2Y-S-DC5V
5 Vdc, 130 ohm coil. DPDT contacts rated 1 Amp @ 30 Vdc, 0.3 Amp @ 125 Vac. 0.79" x 0.4" x 0.4". UL, CSA.

CAT # RLY-338

$1.00 each

100 for $75.00
500 for $300.00
1000 for $500.00

1" SPEAKER WITH POLYPROPYLENE CONE

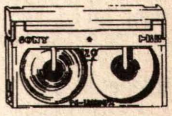
8 ohm, 0.1 watt speaker with clear polypropylene cone. Only 0.15" thick. Good sound quality for its size. Large quantity available.

CAT # SK-218

$1.00 each

10 for $8.50
100 for $70.00
1000 for $500.00

"HI-8" Video Cassette



SONY Hi-8 Top quality, metal particle 120 minute video cassettes. *Used for a short time, then bulk-erased.* Each cassette has its own plastic storage box.

CAT # VCU-8 **$3.00 each**

10 for $28.00 • 100 for $250.00

ORDER TOLL FREE 1-800-826-5432

MAIL ORDERS TO:
ALL ELECTRONICS CORP.
P.O. BOX 567
VAN NUYS, CA 91408-0567

FAX (818) 781-2653 • INFO (818) 904-0524
INTERNET http://www.allcorp.com/
E-MAIL allcorp@allcorp.com

NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D • Shipping and Handling $5.00 for the 48 Continental United States - ALL OTHERS including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.

CIRCLE 214 ON FREE INFORMATION CARD

Our Complete Catalog is now online www.cir.com

Circuit Specialists Inc.

SINCE 1971

Check Out What We Have To Offer:

Fantastic DMM Offer!!!

Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

Our Best Offer Ever on a High Quality Full Sized DMM

$19.00 any qty

General ***Rubber Boot Included***

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity

Overrange Indication: 3 Least Significant Digits Blank

Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%

Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)

Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)

Low Battery Indication: BAT on Left of LCD Display

Dimensions: 188mm long x 87mm wide x 33mm thick

Net Weight: 400g

DC Voltage (DCV)

Range:	*Resolution:*	*Accuracy:*
200mV	100µV	
2000mV	1mV	±(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	*Resolution:*	*Accuracy:*
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	±(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	*Resolution:*	*Accuracy:*
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.

Frequency Range: 45Hz-450Hz

Maximum Allowable Input: 750V rms

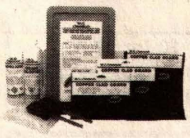
Response: Average Responding. Calibrated in rms of a Sine Wave.

AC Voltage (ACV)

Range:	*Resolution:*	*Accuracy:*
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Positive Photofabrication Kit
Make your own PCB's



Kit includes the basic items needed to fabricate pre-sensitized printed circuit boards (does not include artwork). Also included is a basic process guide to assist the user in the basics of exposing, developing and etching a PCB. All items fit conveniently in the plastic development tray, and a tight fitting lid is included for handy storage. Additional recommended supplies for fabricating PCB's are: exposure bulb, etchant tank, eye protection, art-work, paper towels.

Kit Includes

- 1 each 3"x5" pre-sensitized single sided PCB
- 1 each 4"x6" pre-sensitized single sided PCB
- 1 each 6"x6" pre-sensitized single sided PCB
- 1 each 500ml developer liquid
- 1 each 500ml ferric chloride etching liquid
- 2 each foam brushes
- 1 each plastic development tray
- 1 each rubber gloves
- 1 each instruction sheet

new!

CAT NO	DESCRIPTION	PRICE
416-K	Photofabrication Kit	**$27.95**

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Exposure System

Just place your presensitized board and artwork centered under the exposure fixture. Place the convenient acrylic sheet over the board and artwork to hold everything in place. Turn on light. Voila! Exposure takes about 5 minutes. Kit includes one fluorescent tube, stand and acrylic weight.

new!

Features

- Exposes boards in about 5 minutes!
- Convenient acrylic sheet to hold board in place during exposure (12.5" x 8.5")
- Fluorescent light fixture with plastic cover designed to aid in proper light refractions for even exposure

CAT NO	DESCRIPTION	PRICE
416-X	Fluorescent Exposure System	**$31.95**
416-B	Extra Replacement Fluorescent Tube	**16.95**

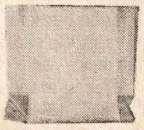
Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

Developer



This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$.95	$.80	$.50

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

CIRCUIT SPECIALISTS, INC.

SINCE 1971 **800-811-5203**
602-464-2485
602-464-5824(FAX)

WE ACCEPT: VISA MasterCard NOVUS

RECEIVE OUR LATEST 132 PAGE CATALOG!

It's chock full of all types of electronic equipment and supplies. We've got I.C.'s. capacitors, resistors, pots, inductors, test equipment, breadboarding supplies, PC supplies, industrial computers, data acquisition products, personal computers and computer parts, plus much, much more. FAX us your name and address or call **800-811-5203, ext. 5,** to leave a message on our catalog request line.

CIRCLE 332 ON FREE INFORMATION CARD

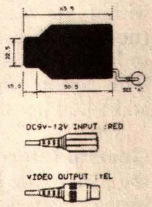
Color Weather Proof Bullet Camera

1/3" CCD with removeable rotation capable mounting bracket

new!

Specifications

Image Sensor:	Interline transfer CCD 1/3" format
Effective Pixel:	512(H)x492(V) pixels/NTSC 512(H)x582(V) pixels/PAL
Scanning System:	2 : 1 interlaced
Sync System:	Internal sync
Sync Pulse:	15.734KHz+1%(H)/15.625KHz +1%(H) 59.94Hz +1%(V)/ 50Hz +1%(V) Sub-Carrier 3.57 MHz +30ppm
Resolution:	400 TV lines (H)
S/N Ratio:	More than 46dB (typ)
Gamma Characteristics:	0.45
Min. Illumination:	1 LUX (F1.2 10 IRE)
Video Out:	Composite video signal : 1.0Vp-p
White Balance:	Auto white balance
Electronic Shutter:	1/60 - 1/100,000 SEC(N) 1/50 - 1/100,000 SEC (P)
Power Supply:	DC 12V + 10%
Power Consumption:	240mA (typ)
Lens:	4mm (78 or 92 degree) F : 2.0
Ambient Operating Temp:	-5 deg. C +40 Deg. C
Ambient Storage Temp:	-10 Deg. C+50 Deg. C RH 95% MAX
Dimension:	2 1/8" (L) x 1 1/4" (D)
Weight:	3 oz.



CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-5407S	Color Water Tight Bullet Camera	$299.00	$269.00

(water tight for outdoor use, not suitable for sustained underwater use)

CCD Bullet Cameras

new!

Available with standard or pinhole lens. Virtually indestructible bullet shaped casing. This sleek B&W camera can be mounted on walls or ceilings along narrow corridors or virtually any location for virtually any surveillance application. 0.5 lux minimum illumination with 380 lines of resolution. Even includes a built-in electronic iris for automatic light compensation.

Features

- Extremely low power consumption
- No blooming, no burning
- 0.5 LUX minimum illumination
- CCD area image sensor for long camera life
- Ultra small size allows for simple application and installation
- Built-in electronic auto iris for automatic light compensation
- Ultra compact camera

Specifications

Image Pick-Up Device:	1/3" CCD area sensor
No. of Pixels:	EIA = 512(H) x 492(V)
Pixel Pitch:	EIA = 9.6uM(H) x 7.5uM
Scanning System:	EIA=525 lines, 60 field/sec
Sync System:	Internal sync
H. Resolution:	430 TU line
V. Resolution:	400 TU line
Usable Illumination:	0.5 Lux F1.6
S/N Ratio:	More than 48dB
Gamma Characteristic:	0.45
Video Output:	1.0 - 1.1 up-p 75 Ohm
Electronic Shutter Time:	EIA=1/60 - 1/50,000 sec
Lens F No. Focal Length:	STD : 1.6 Open / 4.3mm(78 deg) Pinhole: 4.3 fixed/ 2.8mm(91.4 deg)
Power Consumption:	DC 9V (8-10V), 110mA
Operational Temp.:	-10 deg - +50 deg C RH95% max
Storage Temp:	-20 deg - +60 deg C RH95% max
Dimensions:	STD : 22mm(W) x 22mm(H) x 38mm(D) Pinhole: 22mm(W) x 22mm(H) x 30mm(D)
Weight:	35g max

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-07S	Standard Lens Version	$144.00	$129.00
WDB-07P	Pinhole Lens Version	144.00	129.00
WDP-07S/water	Standard Lens Weather Proof	169.00	152.00

CCD Dome Camera with Audio

B&W DOME camera with integrated microphone. Ideal security system application. 12 VDC operation.

new!

Specifications

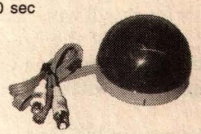


Image Device:	1/3" interline transfer CCD
Picture Elements:	EIA=542(H)x492(V)
Scanning System:	2:1 Interlace
Synchronization System:	Internal
Horizontal Resolution:	380 TV Lines
Sensitivity:	Under 0.3 LUX
Electronic Iris (linear):	EIA = 1/60~1/100,000 sec
Video Output:	1.0vp-p, 75 ohm
S/N Ratio:	More than 50dB
Power Supply:	12V DC (±20%)
Gamma:	r=1
Power Consumption:	110 mA max
Operating Temp.:	-10°C ~ +50° C
Operating Humidity:	RH 95% Max
Weight:	100g
Applied Lens:	3.6mm -92°, 4.3mm -78°
AI/EE/Flicker Less/Mirror Image:	Jump soldering selection
Audio Pick-up Sensitivity:	-60dB (0dB=1V/ubar)
Audio Frequency Range:	20 Hz ~ 20 kHz
Audio S/N Ratio:	More than 40dB
Audio Output Level:	1Vp-p/600 ohm
Dimensions:	87 x 55.5mm

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDDB-6500	B&W Dome Camera	$144.00	$129.00

1/3" CCD Board Cameras

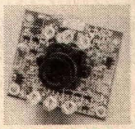
Available with **PINHOLE LENS** with **AUDIO**; **STANDARD LENS** with **AUDIO**; and **STANDARD LENS** with **INFRA-RED and AUDIO**. These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras

Specifications

WDP-2000

WDS-2005



WDI-4000

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 Interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED with Audio	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00

SEE OUR ON-LINE CATALOG AT www.cir.com

CIRCUIT SPECIALISTS, INC.
SINCE 1971

800-811-5203
602-464-2485
602-464-5824(FAX)

ESD Safe Soldering Stations

Standard Tip

- *Auto-Temp 136ESD & Auto-Temp 137ESD*
- *Meets applicable military standards*
- *ESD safe featuring ceramic heating element and state of the art P.T.C. sensor to ensure accurate temperature performance*

Features

Fine Tune Temperature from 150° C (300° F) through 450° C (850° F) without unnecessary tip or heating element changes.
Precision "Tip Temperature" accuracy is mastered to within ±3° C (6° F) using state of the art circuit technology and a built-in P.T.C. sensor located at the top of each ceramic heater shaft for fail safe accuracy.
Fast Heat Up & Recovery. A long life Japanese made ceramic heating element facilitates fast heat up, fast recovery and exacting temperature control with minimal overshoot. Heat-up time to working temperature is attained in about 45 seconds.**Spike Free Circuit.** "Zero voltage" switching and fully grounded design meets military application standards for protection of electrosensitive devices against line transience and voltage spikes. Tip leakage is less than 0.4 mv or 0.5 ohm resistance.**External Calibration Port.** A calibration port is located on the face of the unit thus temperature adjustments are quick and convenient.
Lightweight Soldering Iron. Ergonomic mini handle that stays "cool". Handle assembly cord is made from silicone rubber that won't be damaged when coming into contact with high temperature irons.
Isolated Power Unit. The power unit is isolated from the AC line by a high quality transformer and only 24 Vac voltage is used to drive the heating element. **ESD Safe.** Exceeds all soldering equipment military specifications regarding electro static sensitive devices for critical applications. **Lock-Out Feature:** Constructed with a lock-out feature to allow supervisors only to set and lock specific soldering temperatures. Accomplished via a special sized allen head screw located on the front panel.**Superior High Insulation** ceramic heater provides insulation rated over 100Mohms at 750° F. **Optional SMD Tip Series** for re-work applications. **Range of Interchangeable Tips Available** for maximum system flexibility.

XYTRONICS

136ESD 137ESD w/ Digital R/O

SEE *www.cir.com* FOR OUR SELECTION OF REPLACEMENT TIPS, REPLACEMENT IRONS AND SMD TIPS.

CAT NO	DESCRIPTION	PRICE EACH 1	5
136ESD	Electronic Temp Controlled ESD Safe Soldering Station	$99.00	$88.00
137ESD	Electronic Temp Controlled ESD Safe Soldering Station w/ Digital Readout	129.00	114.00

CIRCLE 332 ON FREE INFORMATION CARD

USE ELECTRONICS NOW CLASSIFIEDS

READ BY ELECTRONIC BUYERS AND SELLERS AND TRADERS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues.**Boldface (not available as all caps)**, add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad**, add 25%. **Tint screen plus all boldface ad**, add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word, Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 -- Antique Electronics	270 -- Computer Equipment Wanted	450 -- Ham Gear Wanted	630 -- Repairs-Services
130 -- Audio-Video Lasers	300 -- Computer Hardware	480 -- Miscellaneous Electronics For Sale	660 -- Satellite Equipment
160 -- Business Opportunities	330 -- Computer Software	510 -- Miscellaneous Electronics Wanted	690 -- Security
190 -- Cable TV	360 -- Education	540 -- Music & Accessories	710 -- Telephone
210 -- CB-Scanners	390 -- FAX	570 -- Plans-Kits-Schematics	720 -- Test Equipment
240 -- Components	420 -- Ham Gear For Sale	600 -- Publications	730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #_____ **Special Category $30.00 Additional** _____

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50	29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50	33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50	37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00				
17 - $42.50	18 - $45.00	19 - $ 47.50	20 - $50.00				
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00				
25 - $ 62.50	26 - $65.00	27 - $67.50	28 - $70.00				

Total words _____ $2.50 per word = $_____

Bold Face _____ $0.40 per word = $_____

Special Heading _____ $30.00 = $_____

Other _____ = $_____

Total classified ad payment $_____ **enclosed** **TOTAL COST OF AD $** _____

[ ] Check [ ] Mastercard [ ] Visa [ ] Discover Card # _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Expiration Date _ _/_ _

Signature_____

Name _____ Phone _____

Address_____City State Zip _____

AMAZING PRODUCTS!

INFORMATION UNLIMITED DEPT EN 0498
BOX 716 AMHERST, N.H. 03031

VISIT OUR "ACTION" WEB SITE@ http://www.amazing1.com

ATTENTION!! RAILGUN EXPERIMENTERS

HIGH ENERGY PULSER

EXPERIMENTORS AND RESEARCHERS

RAIL GUN, COIL GUN, EXPLODING WATER, ANTIGRAVITY, MASS WARPING, LEVITATION, PLASMA PROPULSION, LATTICE SNAPPING, EMP etc

- Lossless Energy Charging
- Programmable Voltage to 2 KV and Energy Control to 3 KJ
- Triggered Spark Switch [1KJ]
- Universal 12 VDC or 115 VAC
- 7.5 X 7.5 X 7" Light weight

HOTSHOT

HEP3 Plans High Energy Pulser/Ignitor.....$15.00
HEP3K Kit/ Plans (With 500 Joules Energy Storage).....349.50
HEP30 Assembled (With 500 Joules Energy Storage).....$449.50
All Individual Parts and Subassemblies Available

BURNING LASER RAY GUN

BLASTS THRU THE HARDEST OF METALS!

All Parts Available

A FUTURISTIC CONCEPT!!

LAGUN2 Plans.....$20.00

BURNING CO2 BENCH LASER

HOTTER THAN MOST TORCHES!

All Parts Available

LC7 Plans.....$20.00

ELECTRONIC HYPNOSIS AND MIND CONTROL

Generates Highly Effective Audible and Visual Stimuli With Bio-Feedback That Can Induce Hypnotic as Well as ALPHA Relaxed States of the Mind. Place Subjects " Under" Your Control. Enhances Hidden PSYCHIC Ability in Many People!

MIND Plans.....$15.00
MIND2K Kit and Plans.....$49.50
MIND20 Assembled.....$89.50

TELEPHONE TAPING SYSTEM

EXTENDED X4 PLAY

Tapes Phone Conversation 20 Megs Input 21 Check Laws!

TAP30X Ready to Use.....$84.50
BEEP10 Beeper Alert.....$29.95

JACOBS LADDER

Observe a pyrotechnical display of "traveling" fiery plasma. Starts off as 1/2" arc and expands to over 3" before evaporating into space. This is an excellent attention getting display as well as a winning science project! With arc control.

JACK1 Plans.....$8.00
JACK1K Kit Minus Case.....$129.50
JACK10 Ready to Use.....$249.50

12KVGEN20 Pwr Supply Only.....$99.50
12KVGEN2K Kit of Pwr Supply.....$79.50

ATTENTION!

ANTI GRAVITY,

We Can Supply Low Cost HIGH VOLTAGE Current Producing Generators from 50 to 500 KV. Contact Factory For Details or Call 603 673 6493

PHASOR BLAST WAVE PISTOL

130 db of Directional Sonic Shock Waves Energy Handheld and Battery Operated

PPP1 Plans.....$8.00
PPP1K Kit/Plans.....$49.50
PPP10 Ready to Use.....$79.50

TRANSISTORIZED TESLA COIL

TURNS A LIGHT BULB INTO A SPECTACULAR PLASMA DISPLAY

Transmits Wireless Energy
Noiseless Operation
Pyrotechnic Effect
12 VDC/5 Amps or Battery
115 VAC Optional Converter
Adjustable Frequency Control For Effect

TCL5 Plans.....$8.00
TCL5K Kit/Plans.....$59.50
TCL50 Ready to Use.....$109.50
12DC/7 12VDC@7Amps.....$39.50

3Mi FM VOICE TRANSMITTER

Safety Product Allows Listening to Children or Invalids in Hazardous Areas, Pools, Ponds etc. Great Security Intrusion Alert! Uses FM Table Top Radio.

FMV1K Kit/Plans.....$39.50

MICRO MINI MITE TESLA COIL

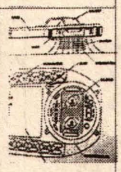
LIGHTS UP A 4 FT FLOURESCENT TUBE WITHOUT CONTACT!!! YET ONLY 3" TALL!

Super Magic Trick
Low Cost Science Project
12 VDC/115 VAC Operation

MTC1K Kit/Plans.....$19.50
MTC10 Ready to Use.....$34.50

HOVERBOARD PLANS

Kit Soon to be Available



28 Pages of "how to" build a magnetic force field capable of containing a column of ionized air up to several psi! Proven theory may require additional experiment

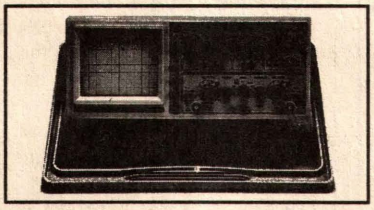
HOVER Plans.....$25.00

1 800 221 1705 ORDERS ONLY! FAX 1 603 672 5406 INFO 9-5pm 1 603 673 4730 FREE CATALOG ON REQUEST

Pay by MC, VISA, Cash, Chk, MO, COD. Please Add $5.00 S&H plus $5.00 if COD. Overseas Please Contact for PROFORMA

New and Pre-Owned Test Equipment

Goldstar



Model OS-9100P → $899.00

Full 100 MHz Bandwidth!

- Dual-Channel, High Sensitivity
- TV Synchronization Trigger
- Calibrated Delayed Sweep
- Includes Two Probes, 2 Year Warranty

Spectrum Analyzer
B+K Precision
Model 2625

- 150kHz - 1050MHz
- 80dB Dynamic Range
- AM/FM demod included

Only $2,195.00!

Pre-Owned Oscilloscope Specials

Tektronix 2213	60 MHz	$549.00
Tektronix 2215	60 MHz	$649.00
Tektronix 465	100 MHz	$599.00
Tektronix 465B	100 MHz	$729.00
Tektronix 475	200 MHz	$829.00
Tektronix 475A	250 MHz	$1,199.00

- Professionally Refurbished
- Aligned & Calibrated to Original Specifications
- The Industry Standard of Oscilloscopes
- **1 Year Warranty** - The Longest Available!!!

We Buy Surplus Test Equipment

SIMMax Module Tester

- Tests 72/30 pin SIMMs
- Stand alone/portable
- Identifies SIMM properties
- 10 built-in tests identify most memory defects

Only $599.00!

See us on the Web!
www.fotronic.com

Leader CATV Signal Level Meter Model LF 941
✓ TV/CATV Coverage from 46 - 870 MHz
✓ Video/Audio Carrier Measurements $695.00!

Just Released! → "Series III" Multimeters

Fluke Model 87III $309.00 !!!

VISA MasterCard AMEX C.O.D.

TOLL FREE 1-800-99-METER

1-800-996-3837

Test Equipment Depot
A FOTRONIC CORPORATION COMPANY
99 Washington St. Melrose, MA 02176
(781) 665-1400 • FAX (781) 665-0780
email: afoti@fotronic.com

CIRCLE 333 ON FREE INFORMATION CARD

CABLE TV DESCRAMBLERS

GUARANTEED LOWEST PRICES
DESCRAMBLERS FOR ALL SYSTEMS
FREE SHIPPING

CRAZY LIZ'S ELECTRONIC WAREHOUSE

CALL TODAY!

1-800-391-7803

EQUIPMENT IS NEW & GUARANTEED

To learn how to talk with your kids about tough issues, like sex, AIDS/HIV and violence, call

1-800-CHILD-44

and get your free guidebook.

Ad Council | CHILDREN NOW | THE DENVER KAISER FAMILY FOUNDATION

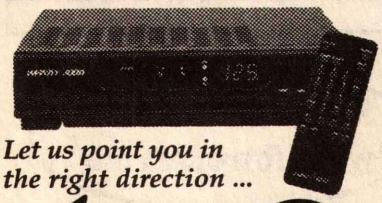
Call Today And SAVE! **Unbeatable PRICES!**

CABLE TV

DESCRAMBLERS
CONVERTERS · FILTERS
VIDEO STABILIZERS

FREE ➤ 30 Day Trial
FREE ➤ Product Catalog
FREE ➤ 1 Year Warranty

100% MONEY BACK GUARANTEE



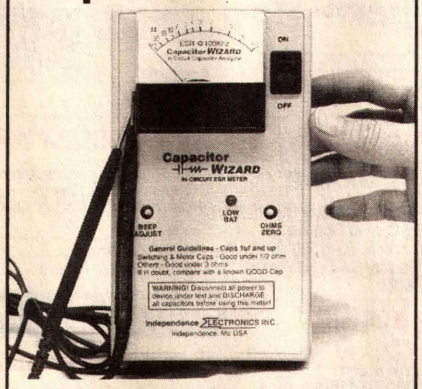
Let us point you in the right direction ...

Arrow Technologies
Omaha, Nebraska

TOLL FREE
888-554-ARROW
888-554-2776

Find Bad Capacitors

In-Circuit with the Capacitor Wizard



The Capacitor Wizard is an extremely FAST and RELIABLE device designed to measure ESR (Equivalent Series Resistance) on capacitors of 1uf and larger "*IN CIRCUIT*", eliminating the need to remove the capacitor for accurate tests. The Capacitor Wizard finds BAD caps *IN CIRCUIT* that even VERY EXPENSIVE cap checkers MISS ENTIRELY, even out of the circuit!! Standard capacitor meters cannot detect any change in ESR therefore they miss bad capacitors leading to time consuming "Tough Dog" repairs. ***Technicians say it is the most cost effective instrument on their workbench.***

Made in the USA

Order Today

Only $179.95

Call 1-800-394-1984

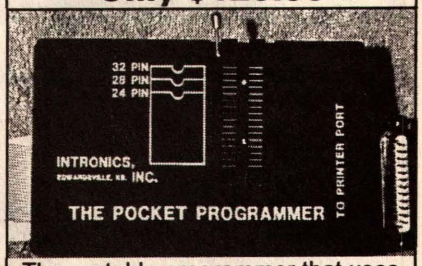
http://www.heinc.com
Int. # 316-744-1993
Fax 316-744-1994
6222 N. Oliver, Kechi, KS 67063

30 day money back guarantee

HOWARD ELECTRONIC INSTRUMENTS INC
Your Desoldering Specialists

The Pocket Programmer

Only $129.95



The portable programmer that uses the printer port of your PC instead of a internal card. Easy to use software that programs Eprom, EEprom, Flash & Dallas Ram. 27(C) / 28(C) / 28F / 29F / 29C & 25XX series from 16K to 8 Megabit with a 32 pin socket. Adapters available for Pic, PLCC, 5-Gang, 874X, 875X MCU's, 40-Pin X 16 & Serial Eprom's, 82/74 Prom's and Eprom Emulator to 32K X 8.

Same Name, Address & Phone # for 16 Years... Isn't it Amazing ?

Intronics, Inc.
Box 13723 / 612 Newton St.
Edwardsville, KS 66113 Add $5.00 COD
Tel. (913) 422-2094 Add $4.00 Shipping
Fax (913) 441-1623 Visa / Master Charge

Free Catalog

If you are not getting this catalog you are missing out on some of the best deals in electronics today! We have thousands of items ranging from unique, hard-to-find parts to standard production components. Call, write, or fax today to start your free subscription to the most unique catalog in the industry, filled with super values on surplus electronic and hobbyist type items. If you have a friend who would like to receive our catalog, send us their name and address and we will gladly forward them a complementary 100 page catalog.

Why pay more? Call today.

MECI

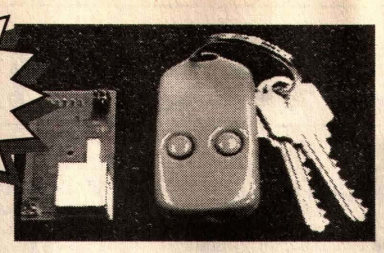
340 East First Street
Dayton, Ohio 45402

Fax Order Line
1-800-344-6324

Order Toll-Free
1-800-344-4465

CIRCLE 251 ON FREE INFORMATION CARD

NEW! µLINK™ SERIES



Send us a (6x9) SASE for your FREE catalog.

µLink™ Infrared Remote Control System

- 4 Channel IR Keychain Transmitter (pcb 1.1"x 1.2") IRTX4-A
- 4 Channel IR Receiver (pcb 1.1"x 1.9") IRRX4-A
- Each receiver can LEARN up to 4 transmitters.
- Each transmitter can have a different access level.
- User selectable receiver output modes.
- Security, Industrial and Home Control Applications
- Up to 9m Range.
- RX and TX IC's available. Custom design service available.

Only $39.95/pair + S&H, additional IRTX4-A units $19.95

SURFACE MOUNT KITS:
- Pager Decoder Interface
- Garage Door Openers
- PLL XTAL FM MIC
- LC tuned FM MIC
- Phone transmitters

Orders: 1-800-417-6689 Mon-Fri 9AM-6PM ET
visa/mastercard/money orders
email: iecorp@i-e-c.com
web: www.irmicrolink.com
IEC ♦ PO Box 52347 ♦ Knoxville TN 37950

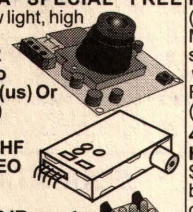
COPYRIGHT ©1998 International Electronics Corp.

BOSSMAN ELECTRONICS

IN THE 2000 OLYMPIC CITY OF SYDNEY, AUSTRALIA
PH 011 61 2 95843562 Fax 011 61 2 95841031 All prices US$
Typical Insured airmail $10-$20 Payment by major credit cards only

APOLOGIES TO ALL In our past advertisements we had some mistakes in our contact details, They have now been rectified & our web page is up & running.

CCD CAMERA SPECIAL FREE BONUS $55 Low light, high Resolution CCD Camera. Very IR Responsive. **Two versions NTSC (us) Or PAL (European) Compatible. PLUS A FREE VHF (US.ch 3-4) VIDEO MODULATOR**

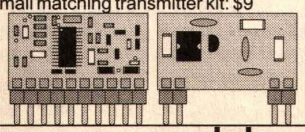


10 LED & 30 LED IR ILLUMINATORS
10 LED $8
30 LED $16

LASER DIODE POINTER (Key-chain) Very bright (650 nM) Pointer. Supplied with 4 extra lens caps that Produce Symbols; CUPID, I LOVE YOU, LOVE HEARTS & A LADY. $22

LASER DIODE MODULE Same quality module That is used in the Above laser pointer: $18 **10 for $150**

UHF DATA TRANSMISSION Stamp sized Xtal locked 433.9MHz superhetrodyne receiver module $20 Small matching transmitter kit: $9



MINIATURE FM TRANSMITTER (33x23x10mm) 88 to 108-MHz (adj.)Metal case, switch, Microphone & wire ant. Bat. life 60 hrs, Range 50M:(G14) $39 (Std. Watch battery LR44, inc.)

4 or 6A PELTIER EFFECT COOLER / HEATER 3.3A@14V $20, 6A @15V $26, approx. 40X40X4mm, temp. can be controlled by supply voltage / current, will work @1.5V. We supply Peltier , data & aplication notes

NIGHT VISION TUBE + SUPPLY Used 25mm fiber optic tube plus an EHT power supply kit to suit. With small side blemish: $35

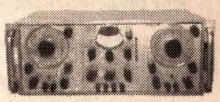
HIGH POWER HIGH FREQ. EHT Plasma discharge in a std. light bulb, or make a JACOBS LADDER or LADEN JAR & other high voltage EHT applications. application notes. Requires 12V @ 0.5-2A **$24**

*******MORE KITS*MORE KITS******* Two channel UHF remote control:$35... Computer stepper motor driver + software:$25...New!!! Improved dog silencer:$28...Alcohol breath tester:$32...Geiger counter:$32..Automatic laser light show:$50

www.world.net/~bossman

AUDIO TEST SETS

HEWLETT-PACKARD 3581A WAVE ANALYZER, separates and measures frequency and amplitude spectral components over 15 Hz to 50 KHz with 1 Hz resolution. Uses 5-digit LED freq- readout & analog meter for amplitude analysis. Meter scales: Volts (30 V - 100 nV linear), 90 dB or 10 dB display (+30 dB to -150 dB log). Sweep scan width adjustable 50 Hz to 50 KHz. Requires 100-120/200-240 VAC 48-440 Hz. Option 003 rack-mount: 10.5x19.3x16.3, 30 lbs. USED-CHECKED, $595.00



MARCONI TF2005 DUAL AUDIO TEST SET, low distortion unit (designed <0.05%) consists of two 20 Hz-20 KHz oscillators, 0.1-111 dB T-attenuator and voltmeter. Output 15 dBm into 600 ohms. Attenuator balanced 75, 150, 600 ohms 1 W max; unbalanced 600 ohms. Voltmeter ranges 1.5, 5, 15, 25 V; dB ranges +10, +20, +24. Requires 115 VAC 50-60 Hz; 7x17x11, 32 lbs sh. USED-REPARABLE with output, $215.00

400 MHZ RADIOSONDE

VAISALA RS80 RADIOSONDE, ultra-light disposable transmitter (400 MHz approx) is designed to be carried aloft by weather balloon and transmit data for air temperature, barometric pressure and humidity to a ground station. Consists of circuit board, dipole antenna, and trailing wire. Requires 9 V battery. "Cute" experimenter item! 12.5"H as shown; 3 lbs sh. NEW, $9.95 ea; 5 for $44.

ELECTRON TUBES, unused military-boxed:

4D32 Raytheon ~~$35~~. $28 ea. 10 for $240. 32/$700.
6336B Cetron, ~~$40~~. $30 ea. 10 for $250. 60/$1320.
5755 Ray or 6922 ECG, $3.50 ea; 10/ $28 one type. 100/$200.
7308 Amperex (not gold-pin, look Russian) $3.50; 100/$200.

Prices F.O.B. Lima, Ohio. VISA, MASTERCARD accepted.
Allow for shipping charges. Write for latest Catalog.
Address Dept. ES + Phone 419/227-6573 + FAX 419/227-1313
E-mail: fairadio@wcoil.com Home: http://www2.wcoil.com/ ~fairadio

FAIR RADIO SALES CO.

1016 E. Eureka + Box 1105 + Lima, Ohio 45802

LASERS

AT GREAT PRICES

Complete Ruby Laser Assembly less than $300
He-Ne Lasers, complete, for less than $50
American 60X Argon Lasers from $595
Laser Diode Modules from under $40
X-Y Scanners from $79

FREE CATALOG

- Helium-Neon
- Argon Lasers
- Diode Lasers
- Holography
- Books
- Ruby Lasers
- Scanners
- Lightshow Equipment
- Pointers
- Optics

Email: mlp@nlenx.com http://www.midwest-laser.com

Midwest Laser Products 30 Day Satisfaction Guarantee.
P.O. Box 262, Frankfort, IL 60423 VISA / MC Accepted
Phone: (815) 464-0085 FAX: (815) 464-0767

Cable T.V.
Converters & Equipment

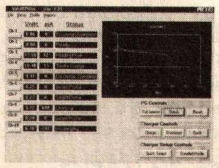
Lower Prices
Dealer Discounts
30-Day Money back
1-year warranty
MC, Visa, AE, COD

Pro Planet

No Florida Sales
www.cable4you.com
1-(800) 888-5585

Battery Analyzer

PC-Controlled Battery Analyzer
Cycle, Charge & Test with your PC
Print reports, plot graphs, expandable **$398**



Tel: 800-673-3585
519-472-5566
Fax: 519-472-1702

Download Demo:
http://home.rogerswave.ca/lamantia
lamantia@compuserve.com

LaMantia Products Ltd.

BEST DEALER PRICING!

CABLE DIRECT
CONVERTERS • FILTERS
DESCRAMBLERS

IMPROVE YOUR IMAGE WITH
VIDEO STABILIZERS

FREE CABLE TV CATALOG!

100% MONEY BACK GUARANTEE!

30 DAY FREE TRIAL!

Now you can tune-in your favorite cable TV programming and **SAVE $100'S - EVEN $1000'S** on premium **CABLE TV EQUIPMENT.**

MODERN ELECTRONICS
1-800-906-6664
2609 S. 156TH CIRCLE • OMAHA, NE 68130
http://www.modernelectronics.com

CLASSIFIED

BUSINESS OPPORTUNITIES

Have a New Product/Idea? Full Marketing and Patenting Services. Call 1-800-846-8368 Ext. 303. **Free** Information Kit.

EASY WORK! EXCELLENT PAY! Assemble Products At Home. Call Toll Free 1-800-467-5566 ext. 5192.

$400 WEEKLY ASSEMBLING Electronic circuit boards/products from home. For free information send SASE: Home Assembly-EN Box 216 New Britain, CT 06050-0216.

CABLE TV

CONFUSED?? Descramblers. Will explain all your options, all makes and models avl. Dealers are welcome. Open 6 days 9AM till 7PM EST, Toll Free# (888)238-0967. **ROYAL ENGINEERING INC.** Universal Box is here now.

CABLE TV Descramblers. One piece units. Scientific Atlanta, Jerrold, Pioneer, and others. Lowest prices around. **Precision Electronics** Houston, TX. Anytime. 1-888-691-4610.

WHOLESALE and volume pricing. **Boss** units and **Seemores** compatible with all systems. C.O.D. Call and compare prices 1-888-762-2253.

Bewildered about descramblers? Call for fast friendly explanation on your cable needs. Same day shipping or shipping is free. Tech. support with all orders. Call Toll free 1-888-221-8365. Global Electronics M-Sat. 9am-8pm.

CABLE TV Signal Eliminator - Powerful, user tunable filter for removing severe interference OR unwanted channels! Eight models, for channels (2-3)(4-6)(7-13)(14-17)(18-22)(23-29)(30-36)(95-99). Each $30, add $4 for S/H. Quantity discounts. Money back guarantee. Visa, Mastercard or check. COD $5 extra. Visit starcircuits.com. **Star Circuits**, PO Box 94917, Las Vegas, NV 89193. 1-800-433-6319.

Free Cable Descrambler Plans. For Details Write: Sierra Publishing, 909 E. Yorba Linda Blvd., Suite H-181, Dept ENU, Placentia, CA 92870.

CUBE for Jerrold Model CFT-2200, 2014, 2024, 2254, Pioneer 6300-6310, Auto-Multimode, Zenith ST-1600 $175.00. Lowest price call 800-822--8530.

CABLE TV EQUIPMENT & ACCESSORIES. Wholesalers Welcome! 30 Day Moneyback Guarantee! Free Catalog! **PROFORMANCE ELECTRONICS, INC. 1-800-815-1512.**

Descramble cable with simple circuit added to RadioShack RF Modulator and using VCR as tuner. Instructions $10.00. **TELCOM** Box 832E11 Brusly, LA 70719

Cable boxes all models, all channels, lowest prices in the United States. Open seven days a week till midnite, Pacific time. Call (877)789-7337 toll-free.

Cable Descramblers, including activators for all Jerrold Dp5-CFT 22xx's and SP's, AUTO **MULTIMUDE**, and FIBER **OPTICS**. Descrambles everything **PERMANENTLY**, guaranteed. Lowest single or lot prices. Also, ZENITH, **SCIENTIFIC ATLANTA**, and **PIONEER**. Se habla en espanol. Call 888-684-9277.

Wholesale unmod 10 lot only VIP $50, Pio 5130 $50, Zenith 1000 $15, Jerrold DPV5 $28, DR23 W/R P,IN 8⁰⁰ SA 8570 $75, Call **APEX** 1-800-500-9825.

NEW! Cellphone E.S.N. readers **$250** each, cell phone programmers **$175** each, cell phones **$25** each, DSS satellite dish card readers and programmers **$125** each, credit card readers **$250** each, Cable T.V. notch filters **50 cents** each, convertor boxes **$50** each, magnetic strip card readers for ATM machines, bank cards, drivers license, and all types of data acquisitions all under **$200** each. You pay these super low prices when you deal directly with the manufacturers. When you order "Direct Connection" a 150 page directory published by Ed Treki Publications, you will receive the largest collection of names, addresses, and phone numbers of all the leading American and International manufacturers of these products never before available. Stop paying second, third and fourth hand prices and deal directly with the source!!! Order your copy of "Direct Connection" today for **only $99.95 plus $5 shipping. All orders are sent C.O.D. Please call Ed Treki Publications 24 hour order hot line 914-544-2829.**

CABLE DESCRAMBLING, New secret manual. Build your own Descramblers for Cable and Subscription TV. Instructions, schematics for SSAVI, Gated Sync, Sinewave, $12.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

CABLE test modules/cubes. Pioneers, S/A, Tocoms, Jerrolds. Quantity discounts, Call **DCR**: Tel: (718)624-8334 Fax: (718)246-9731. No NY calls.

For all your cable needs, Quantity Discounts, low, low price. 30 day money back guaranteed. Call now 888-898-3284, Skylab Sales Inc.

ALL CABLE TV CONVERTERS & ACESSORIES. LOWEST PRICES. 30 DAY TRIAL. 1 YEAR WARRANTY. 1-800-538-CABLE(2225).

CB-SCANNERS

CB Radio Modifications! Frequencies, kits, high-performance accessories, books, plans, repairs, amps, 10-Meter conversions. The best since 1976! Catalog $3.00. **CBCI**, Box 1898EN, Monterey, CA 93942.

CB Trick Books, three books 1,2 and 3. Each book 19.95 each. Repairs, tune ups, and amplifiers. Send money order to **Medicine Man CB** P.O. Box 37, Clarksville, AR 72830.

EDUCATION

Learn electronics. Home study. Outstanding careers. Free literature. **P.C.D.I.**, Atlanta, Georgia. Call 800-362-7070. Dept. ELM342.

PLANS-KITS-SCHEMATICS

ELECTRONIC PROJECT KITS: 49 McMichael St, Kingston, ON., K7M 1M8. $3.00 catalog. www.qkits.com. **QUALITY KITS.**

CATALOG: Broadcasting/micro transmitters, amplifiers, antennas. **Start your own radio station books.** Audio, TV, Ham, CB, Surveillance, Science projects and more. **www.panaxis.com PAN-COM Int'l,** PO Box 130-11, Paradise, CA 95967.

Laser experimenter's catalog, circuit boards, controller chips, hard to get parts, plans, $2.00 **MCS Research** 15611 Colorado Blvd. Brighton, CO 80601.

AWESOME KITS: Voice Changers, Levitators, Lasers, Gas Sensors and more! Catalog $1.00. **LNS Technologies,** PO Box 67243, Scotts Valley, CA 95067 www.ccnet.com/~LNSTECH.

SATELLITE EQUIPMENT

FREE CATALOG - Satellite TV/GPS-DIY. Technical Books, Installation Videos, Computer Analysis Software **www.baylin.com** 800-843-2425.

SKYVISION! Your Satellite Home Entertainment Source. **Best values**: DBS and C/Ku-band equipment, including 4DTV. Most complete selection: Parts-Tools-Upgrades-Accessories! **Free** Discount Buyer's Guide. Call 800-543-3025. International 218-739-5231. www.skyvision.com.

DSS Hacking: How to construct and program smart cards, with pic16C84, PCB layout, Complete DSS system schematics, $16.95. Software $25. **CABLETRONICS** Box 30502R, Bethesda, MD 20824

SECURITY

SECURITY Systems and Surveillance Camera Equipment. Do it yourself and save. Camera's, Monitor's, VCR's, Motion and Glassbreak Detector's, Control Panel's, Siren's, more. www.a1security.com.

TEST EQUIPMENT

TEST EQUIPMENT SALE Complete listing at http://www.astglobal.com or call **NOW** to receive list by fax or mail. **AST GLOBAL ELECTRONICS:** Voice: 888-216-7159, Fax: 814-398-1176, e-mail: sales@astglobal.com

WANTED

WANTED: USED TEST EQUIPMENT. TURN IDLE OR EXCESS EQUIPMENT INTO CASH. AST GLOBAL ELECTRONICS: Voice: 888-216-7159, Fax: 814-398-1176, e-mail: sales@astglobal.com

CALLER ID ON TV

NEW! CALLER-TV $49.95 NO MORE INTERRUPTIONS! Know who's calling immediately. Secure internet ordering www.caller-tv.com, 520-544-4567.

SCRAMBLING NEWS

Pay TV and Satellite Descrambling: 1999 Edition. All the latest cable and satellite fixes. Free catalog. 941-646-2564 or www.scramblingnews.com.

BEST BY MAIL

Rates: Write National, Box 5, Sarasota, FL 34230

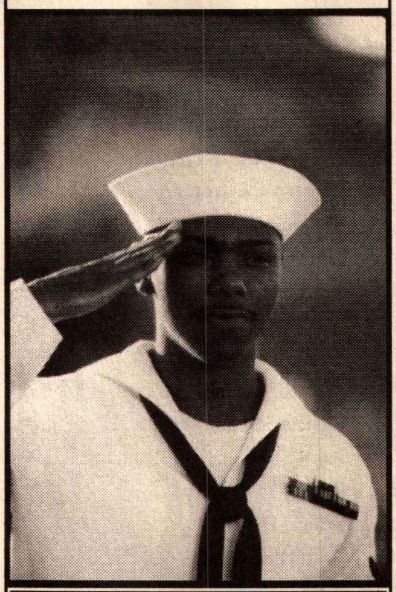
GAMBLING

HOW TO WIN BOOKS - Buy Our Lottery, Football, Baseball, Horse, Bingo, Poker and More. For details write to: Marlin Mull, 142 S. Front St., Milton, PA 17847.

MONEYMAKING OPPORTUNITIES

$156,250.00 IN 6 MONTHS! For Information Send $1.00 and SASE to: EDB, Box 127, Rule, TX 79547.

PLEDGING OUR ALLEGIANCE

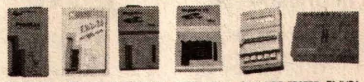


United States NAVY

1-800-USA-NAVY
www.navyjobs.com

PROGRAMMERS OVER 50 MODELS

ADVANTECH EETOOLS NEEDHAMS DATA I/O ICE TECHNOLOGY HILO SYSTEM GENERAL CHROMA MODULAR CIRCUIT TECHNOLOGY XELTEK



PROMAX EMP-20 MEGAMAX MEGAMAX4 SIMM/SIP TESTER EMUPA

CALL ADVANTECH LABTOOL	599 EETOOLS SIMMAX
629 ICE TECH MICROLV	795 CHROMA SIMM/SIP
650 EETOOLS ALLMAX +	359 MOD-MCT-EMUPA/R
409 EETOOLS MEGAMAX	279 MOD-MCT-EMUP/R
509 EETOOLS MEGAMAX4	49 EPROM 1G TO 512K
369 XELTEK SUPERPRO II	69 EPROM 1G TO 1MEG
409 XELTEK SUPERPRO II P	99 EPROM 4G TO 1MEG
249 XELTEX SUPERPRO L	199 EPROM 16G TO 1 MEG
165 XELTEK ROMMASTER II	89 EPROM 1G TO 8MEG
479 MOD-MCT-EMUPA	129 EPROM 4G TO 8MEG
739 STAG ORBIT-32	250 EPROM 8G TO 8MEG

LABTOOL48 MICROMASTER SUPERPRO ALLMAX PLUS ROMMASTER2

General Device Instruments

Sales 916-393-1655 Fax 916-393-4949 BBS 983-1234

Web www.generaldevice.com E-Mail icdevice@best.com

GALEP-III

Pocket Multiprogrammer

This size fits all!

◆ Programs 8-bit and 16-bit EPROMs, EEPROMs, Zero Power RAMs, Flash, serial EEPROMs ◆ GAL, PALCE, ATF ◆ 87xxx, 89xxx, PIC12/16/17Cxx ◆ All DIL devices **without adaptor** ◆ **Lightning fast** parallel data transfer (e.g. 27C512 read/compare 2 sec!) ◆ Power supply independent due to **rechargeable battery** ◆ Uses PC printer port ◆ Hex, JEDEC, and binary file formats ◆ Hex and fusemap buffer editor ◆ Split & shuffle for 8-bit, 16-bit and 32-bit targets ◆ Runs under Win3.1, 95, 98 ◆ 'Remote control' by DDE scripts ◆ Designed for the future due to flexible pin driver technology - new devices will be added every month ◆ Device list, demo software and **lifetime free updates** from our website www.conitec.com!

GALEP-III Set with cable, battery, recharger **$389.00**

PLCC Adaptor for 8-bit EPROMs / 16-bit EPROMs / GALs .... **each $149.00**

CONITEC 1951 4th Ave, Ste 301 • San Diego, CA 92101 Tel: (619) 702-4420 • http://www.conitec.com

MICROTEST INC.

CABLE TEST CHIPS FROM $9.95

WE STOCK A COMPLETE LINE OF CHIPS
WE ALSO HAVE CRYSTAL 119.MHZ117.MHZ
...WARNING...
ANYONE IMPLYING ILLEGAL USE WILL BE DENIED SALE. WE SELL PRODUCTS ONLY TO TECHNICIAN OR REPAIR FACILITIES
ALL ORDERS SHIP VIA UPS/ECT
THE BEST PRICE IN THE MARKET
WE INCLUDE SWICH & RESISTER
MON-SAT 8 AM-7 PM EST .TECH SUPPORT
E-MAIL WWW.MICROTEST@AOL.COM

FOR ORDERS 1800-931-9440

One tree can make 3,000,000 matches.

One match can burn 3,000,000 trees.

5 Axis Robotic Arm $195.00 *Plus S&H*

Lynxmotion

You can build this Robotic Arm

Impressive, fast, accurate, and repeatable motion. Any computer or micro capable of sending 2400 or 9600 baud serial data can control the arm. It can even be controlled from a Basic Stamp. This robot arm makes a great foundation for many AI and motion control experiments. Position the arm in an X, Y, Z, grid with a joystick or keyboard using the new RoboMotion for Windows. The kit includes the hardware, structural components, Hitec servos, pre-assembled SSC servo controller, DOS and Windows software, and an illustrated assembly manual. Camouflage paint not included.

We have many more cool robots, check out our web page or ask for our free catalog!

Lynxmotion, Inc.
104 Partridge Road
Pekin, IL 61554-1403
www.lynxmotion.com

MasterCard VISA

Tel: 309-382-1816
Fax: 309-382-1254
sales@lynxmotion.com
tech@lynxmotion.com

ADVERTISING INDEX

Electronics Now does not assume any responsibility for errors that may appear in the index below.

Free Information Number		Page
—	Abacom Technology	76
—	ABC Electronics	68
—	AES	92
213	Alfa Electronics	62
214	All Electronics	93
—	Allison Technology	81
—	Amazon Electronics	66
282	American Eagle Publications	83
218	American Innovations	65
—	Andromeda Research	90
—	Arrow Technologies	82, 98
—	Associated Electrical & Eng.	65
313	Basic Electrical Supply	80
337	Beige Bag	77
—	Bossman Electronics	99
—	Brand Electronics	79
—	Bsoft Software, Inc.	92
322	C&S Sales, Inc.	72
—	Cable USA	88
332	Circuit Specialists	94
—	CLAGGK, Inc.	12
—	Cleveland Inst. of Electronics	3, 53
—	Command Productions	76
—	Computer Monitor Maintenance	68
—	Conitec	101
226	Consumertronics	78
228	Cool Amp Conducto Lube	81
—	Crazy Liz's	98
234	Dalbani Electronics	67
235	Danbar Sales	84
—	EDE - Spy Outlet	84
—	Electronic Tech. Today	10, 23
—	Emac Inc.	76
—	Fair Radio	99
335	Foley-Belsaw	89
—	General Device Instruments	101
131	Global Specialties	7
—	Grantham Col. of Engineering	4
329	Graymark International	62
—	Home Automation	90
331	Howard Electronics	71
—	Howard Electronics	98
—	IEC	99
—	Information Unlimited	97
—	Intec Automation	66
138	Interactive Image Technologies	CV4
—	Intronics, Inc.	98
319	IVEX Design	91
—	J&M Microtek, Inc.	66
—	James Electronics	68
—	Lindsay Publications	84
—	Lynxmotion	101
—	M2L Electronics	82
325	Mark V Electronics	74
327	MCM Electronics	CV3
251	Mendelson Electronics Surplus	98
324	Merrimack Valley Systems	92
—	Micro Test	101
133	MicroCode Engineering	CV2
—	microEngineering Labs	84
—	Midwest Laser Products	99
—	Modern Electronics	100
—	Mondo-tronics Inc.	88
318	Mouser Electronics	82
219	Netcom	79
—	NRI Schools	33
—	NYE Electronics	82
—	PC Boards	83
—	Pioneer Hill Software	88
—	Point Six	90
220	Polaris Industries	78
215	Prairie Digital	77
264	Print (Pace)	64
150	Radio Shack	5
266	Ramsey Electronics	87
216	Roger's Systems Specialist	85
—	Science Fair Electronics	66
—	SE International	77
270	Skyvision Inc.	75
—	Square 1 Electronics	79
314	Sun Equipment	63
—	Sylva Control Systems	66
—	Tab Books	9, 69
—	Techniks	66
—	Technological Arts	66
311	Telulex	83
333	Test Equipment Depot	97
217	Test Equipment Sales	86
275	Timeline	80
—	U.S. Cyberlab	90
—	Video Media	66
259	Viewers Choice Electronics	61
310	Visitect Inc.	86
—	Weeder Technologies	65
—	World Star Technologies	66

ADVERTISING SALES OFFICES

Gernsback Publications, Inc.
500 Bi-County Blvd.
Farmingdale, NY 11735-3931
1-(516) 293-3000
Fax 1-(516) 293-3115

Larry Steckler
publisher (ext. 201)
e-mail advertising@gernsback.com

Adria Coren
vice-president (ext. 208)

Ken Coren
vice-president (ext. 267)

Christina Estrada
assistant to the publisher (ext. 209)

Arline Fishman
advertising director (ext. 206)

Marie Falcon
advertising assistant (ext. 211)

Adria Coren
credit manager (ext. 208)

For Advertising ONLY

EAST/SOUTHEAST
Megan Mitchell
9072 Lawton Pine Avenue
Las Vegas, NV 89129
Phone 702-240-0184
Fax 702-838-6924
Lorri88@aol.com

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Midwest Advertising
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-847-559-0555
Fax 1-847-559-0562
bergenrj@aol.com

PACIFIC COAST
Janice Woods
Pacific Advertising
Hutch Looney & Associates, Inc.
6310 San Vicente Blvd., Suite 360
Los Angeles, CA 90048-5426
1-323-931-3444 (ext. 228)
Fax 1-323-931-7309
janice@hlooney.com

Electronic Shopper
Joe Shere
National Representative
P.O. Box 169
Idyllwild, CA 92549-0169
1-909-659-9743
Fax 1-909-659-2469
Jshere@gernsback.com

Megan Mitchell
National Representative
9072 Lawton Pine Avenue
Las Vegas, NV 89129
Phone 702-240-0184
Fax 702-838-6924
Lorri88@aol.com

Customer Service
1-800-999-7139
7:00 AM - 6:00 PM M-F MST

MCM ELECTRONICS®

The Source For All Of Your Electronics Needs

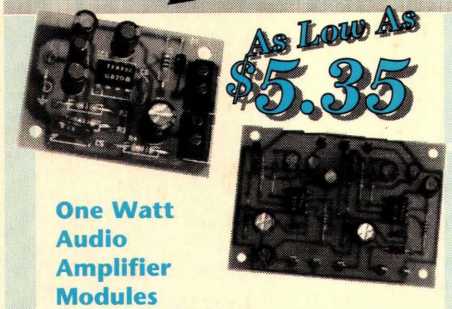
When ordering, please provide this code: ▶ SOURCE CODE: ENS52

Prices Effective Oct. 6 through Dec. 4, 1998

For over 20 years, MCM has been the leading supplier to the electronics service industry. Huge inventory, rapid delivery and competitive prices have made MCM the choice for:

- Hobbyists
- Service Technicians
- Educators
- Installers

Discover the MCM difference, call today for your free catalog.



As Low As $5.35

One Watt Audio Amplifier Modules

Pre-assembled PC boards are great for projects and repair. Each accepts line level input and provides 1W RMS output at 8ohms. Operates on 4~14DC, 250mA max (#28-4795 200mA).

Order #	Type	Dimensions(mm)	Reg.	Sale
28-4795	Mono	50 x 35 x 20	$7.49	$5.35
28-5170	Stereo	50 x 75 x 20	14.95	10.65

ONLY $89.00

Order #72-6000

TENMA®

Digital Multimeter w/RS-232 Interface

Features quad display plus bargraph, autoranging operation and measurement of AC/DC voltage, resistance, current and capacitance. Includes test leads, serial cable and software.
Regular price $129.00

Order #32-4420 ONLY $9.50

Four Position A/V Selector

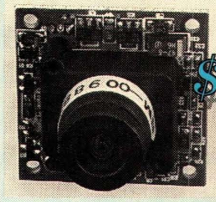
Perfect for the entertainment center. Switches L/R audio and video from up to four sources. All connections are RCA female. Switches 20Hz~10MHz.
Regular price $15.50

ONLY $48.50

Order #55-1930

18" Low Frequency PA Speaker

Poly treated paper cone and accordion surround make this perfect for PA or home applications. 45 oz. magnet and 2" voice coil combine for power capacity of 125W/250W RMS/peak and frequency response of 20Hz~3.5KHz. 8ohm.
Regular price $64.95



ONLY $49.00

Order #82-2990

DEFENDER SECURITY

Micro PC Board Camera

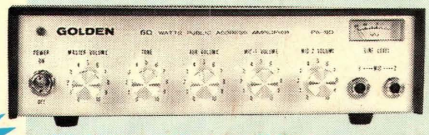
Ultra compact black and white CCD camera measures only 1¼" x 1¼" x 1". Provides NTSC composite video output. Built-in 3.6mm lens provides viewing angle of 92°. Requires 12VDC, 300mA.
Regular price $64.95

ONLY $18.50

Order #21-1915

1000W Heat Gun

Professional quality gun is ideal for heat sealing, curing and heat shrink tubing. Two temperature ranges allow operation at 600W and 1000W. Requires 120VAC, 1200W. **Regular price $42.75.**



ONLY $69.00

Order #80-190

50 Watt PA Amplifier

Perfect for auditoriums, churches and office buildings. Inputs include two ¼" microphone, ceramic phono and aux. Special fader allows phono/aux mixing. Outputs include 4, 8 and 16ohm, plus 70Vand 100V line. Requires 117VAC/12VDC. Measures: 13" x 4½" x 10½". **Regular price $201.00**

ONLY $36.75

Order #102-025

127 Piece Heat Shrink Tubing Kit

Quality kit features ICO Rally heat shrink and includes an assortment of the following sizes: 1/16", 3/32", ⅛", 3/16", ¼" and ⅜". Colors include black, clear, red, green, white, blue and yellow. Refills available.

FREE Catalog!

1-800-543-4330

www.mcmelectronics.com

Hours: M~F 7 a.m.~9 p.m., Sat. 9 a.m.~6 p.m., EST.

Same Day Shipping!
In stock orders received by 5:00 p.m. (YOUR TIME), are shipped the same day.

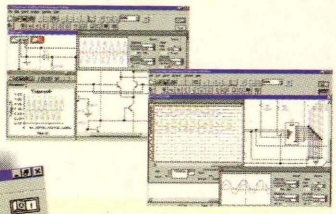
MCM ELECTRONICS®
650 CONGRESS PARK DR.
CENTERVILLE, OH 45459
*A **PREMIER FARNELL** Company*

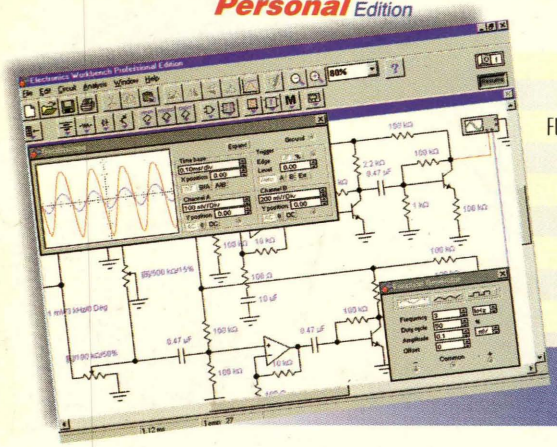
SOURCE CODE: ENS52

CIRCLE 327 ON FREE INFORMATION CARD

THE WORLD'S MOST POPULAR DESIGN TOOL CHOSEN BY OVER 100,000 USERS!

Electronics Workbench® Personal Edition



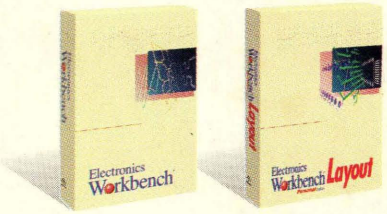


TRUE MIXED ANALOG/DIGITAL
FULLY INTERACTIVE SIMULATION
PRO SCHEMATIC EDITOR
6 VIRTUAL INSTRUMENTS
ON-SCREEN GRAPHS
OVER 4,000 MODELS
8 POWERFUL ANALYSES
FREE TECHNICAL SUPPORT

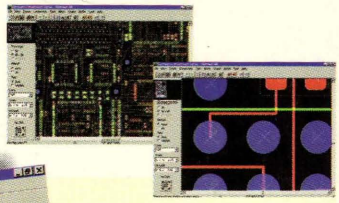
$299

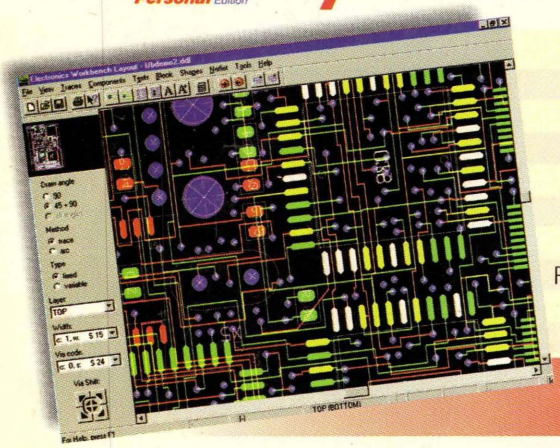
Full-featured schematic capture and SPICE circuit simulation!

The world's most popular circuit design tool that sets the standard for powerful, insightful SPICE simulation. Create professional looking schematics and then with the flick of a switch, display simulated waveforms live on a suite of virtual instruments. Includes 15 powerful analyses and a library of over 4,000 robust component models.



Electronics Workbench® Layout Personal Edition





AUTOROUTING
REROUTE WHILE MOVE
32 ROUTING LAYERS
50" X 50" BOARD SIZE
OVER 3,500 LIBRARY SHAPES
EXTENSIVE OUTPUT
REAL TIME DESIGN RULE CHECK
DENSITY HISTOGRAMS
FREE TECHNICAL SUPPORT

$299

Power-packed PCB layout with autorouting and real-time DRC!

EWB Layout is a powerful board layout package for producing high-quality, multi-layer printed circuit boards. Offering tight integration with our schematic capture program, EWB Layout is the best way to quickly produce well-designed boards.

BUY BOTH AND SAVE! ~~$598~~ $548

30-DAY MONEY-BACK GUARANTEE

CALL FOR INFORMATION AND PRICING ON OUR PROFESSIONAL EDITION.

800.263.5552

Fax: 416-977-1818
E-mail: ewb@interactiv.com

INTERACTIVE

For a free demo, visit our website at www.electronicsworkbench.com

CIRCLE 138 ON FREE INFORMATION CARD